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EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, January 14th, 1890.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

Mr. J. C. Horobin, B.A., of Emmanuel College, Cambridge, and The llege, Homerton, E., and Mr. A. Hutchinson, B.A., of Christ's llege, Cambridge, were elected Members of the Society.

The death of Lord de Blaquière, Trustee and Member of the Society, s announced.

Professor N. S. Maskelyne, M.P., F.R.S., was elected to the vacant usteeship.

GENERAL MEETING.

Held in the Apartments of the Geological Society, January 14th, 1890.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

The following papers were read :—

"On New Localities for Zeolites." By Professor M. F. Heddle, M.D., R.S.E.

"On Zinc-Sulphide encrusting Stibnite: Analyses of Stephanite and ybasite." By G. T. Prior, M.A. (page 9.)

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, March 18th, 1890.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

The resignation of Mr. J. W. Crocker, and the death of Mr. E. F. rton, both Associates of the Society, were announced.

GENERAL MEETING.

Held in the Apartments of the Geological Society, March 18th, 1890.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

The following papers were read :—

"On the Meteoric Iron of Tucson." By Mr. L. Fletcher, M.A., R.S. (page 16.)

"An Account of a Visit to the Calcite-Quarry in Iceland." By Mr. L. Hoskyns-Abrahall. (Communicated by the Secretary.) (page 179.)

"Mineralogical Notes." By Mr. H. A. Miers, M.A., F.G.S. (page 182.)

Specimens were exhibited in illustration of the papers of Mr. Abrahall d Mr. Miers: also a specimen of the barium sulphate of Perkin's Mill, t by Dr. G. C. Hoffmann, of the Geological Survey of Canada.

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, May 20th, 1890.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

The audited Balance Sheet for the year 1889 was submitted, and ordered to be issued with the next number of the Journal (page vii.)

A proposal to exchange publications with the Editor of the *Giornale di Mineralogia* was accepted.

GENERAL MEETING.

Held in the Apartments of the Geological Society, May 20th, 1890.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

The following papers were read:—

"On the Mexican Meteorites, with especial regard to the supposed occurrence of wide-spread Meteoritic Showers. By Mr. L. Fletcher, M.A., F.R.S. (page 91.)

"On Svecium, a supposed new metallic element from the Hausmannite- and Braunite-mine, Sjögrufvan." By Mr. L. J. Igelström. (Communicated by the Secretary.)

"Notes on Bowenite, or Pseudo-Jade, from Afghanistan." By Major-General C. A. McMahon, F.G.S. (page 187.)

"On the Relations between the Gliding Planes and Solution Planes of Augite." By Professor J. W. Judd, F.R.S. (page 192.)

Crystals of Corundum were exhibited by Professor Judd, and specimens of the Afghan Bowenite by Major-General McMahon.

RECEIPTS.

	£	s.	d.
Balance from year 1888	13	1	1
Subscriptions:—(1) in advance	1	1	0
,, (2) current	73	8	6
,, (3) in arrear	13	18	0
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	£	s.	d.
Printing and Stationery	86	9	9
Care of Stock of Publications and Insurance (1888)	5	9	0
Illustrations	12	8	0
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Preparation of list of contents of Library	0	12	6
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Investments	13	11	7
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Balance	12	5	1
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Examined and compared with the vouchers and found correct. (Signed)

BENEDICT KITTO,
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25th March, 1890.

LIABILITIES.

	£	s.	d.
Williams & Strahan, Printing, &c.	57	18	2
Received in advance (Subscription)	1	1	0
,, ,, (Sale of Journal)	0	19	0
Excess of Assets over Liabilities	220	8	5
	£280	6	7

Number of Life Members 30.

ASSETS.

	£	s.	d.
Subscriptions for 1887-9 unpaid	12	12	0
Stock in 2¾ Per Cent. £251 10s. 8d. at 97⅝	244	6	0
Proportion of Interest on Stock unpaid	1	13	9
Sale of Journal:—(1) due from the Publishers	14	4	3
,, ,, (2) due on Office Account	3	16	1
Due for Authors' extra copies	3	14	6
	£280	6	7

The Stock of Publications and the Library are not included in the above assets.

(Signed)

L. FLETCHER,

General Secretary.

THE MINERALOGICAL MAGAZINE

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MINERALOGICAL SOCIETY.

No. 42. AUGUST, 1890. Vol. IX.

On the Mexican Meteorites, with especial regard to the supposed occurrence of wide-spread meteoritic showers.

By L. FLETCHER, M.A., F.R.S.,
Keeper of Minerals in the British Museum.

(*With maps of the region, Plates I. and II.*)

[Read May 20th, 1890.]

Introduction.

IN a recent paper[1] descriptions were given of some meteoritic masses, which had been brought from the Desert of Atacama and are now in the British Museum. Several of them were independent of those preserved in other Meteorite Collections, in that they showed no signs of having been broken since their discovery; but it still remained to determine whether they might not possibly belong to meteoritic showers, of which individual masses had been already collected and described. For this a minute investigation of the meteoritic literature of the Desert

[1] *Mineralogical Magazine*, 1889, vol. 8, p. 223.

of Atacama was necessary. In the course of the investigation, it becan clear that the prevalent belief in wide-spread meteoritic showers, wheth true or untrue in general, was, as regards the Desert of Atacama, bas on insufficient evidence : that in one case the wide-spreading of a show was undoubtedly caused by a mere interchange of labels ; in another misinterpretations of the statements relative to a locality ; that while t places were widely separated from which other fragments, belonging to single type, had been brought, they were on definite and dangerous lin of traffic, along which similar fragments are known to have been carried the backs of capricious mules : further, that the statement that "meteorit were found at every step in the Desert" had been made at a time wh almost the whole of the Desert was untrodden and unexplored : finall that the latest explorations did not suggest the existence of meteori masses at small distances from each other over any large area of t part of South America.

Attention was thus directed to the following facts:—(1) only ni falls of meteoric iron are known to have been observed since the ye 1751 ; (2) not more than two masses of iron have been seen to f simultaneously ; (3) the largest (Nejed) weighed only 131 lbs. ; (4) fa of stones, sometimes thousands in number, have been often observe (5) the largest authenticated separation for the individuals of a single fa whether of stone or iron, has been sixteen miles ; (6) in some regio meteoric iron will endure for ages before rusting completely away ; (7) t discovery of numerous masses of iron in certain districts may be due the circumstance that the ground has been unexplored, or at least u cultivated, during many centuries.

It has already been distinctly pointed out by Professor Daubrée[1] that t small dispersion of a meteoritic fall is suggestive of the entry into terrestrial atmosphere of only a single mass, afterwards fractured by enormous resistance of the air : for the individuals of a swarm meteoritic masses, various in form and size, would experience resistan so different in magnitude, that the residual masses would probably scattered over areas of the earth's surface much larger than those wh have characterised any of the observed falls.

The converse is not necessarily true, for a wide separation of terminal individuals of a meteoritic fall might conceivably be due to succ sive fractures of a single primitive mass. And it may be worthy of rem that, but for the differential action of the atmospheric resistance,

[1] *Études Synthétiques de Géologie Expérimentale*, *Paris*, 1879, p. 672.

dispersion consequent on the breakage of the primitive mass would be very small, however numerous the so-called explosions, since each fragment would retain the enormous velocity belonging to it as part of the original moving body: that by simple division a single mass, or a swarm, could succeed in "dropping" fragments at distant points of the line of flight is mechanically impossible.

Remembering the close similarity in structure and material of the single representatives of meteoritic falls to those which have been picked up in hundreds or even thousands, and the identity in character of the luminous and also of the detonatory phenomena in the different cases, it is difficult to grant that the enormous disparity in the numbers of the individual masses, which have been found after different meteoritic falls, is satisfactorily explained by any possible diversity in structure or velocity of singly entrant blocks.

It cannot be said, however, that all the consequences of the entry into the terrestrial atmosphere of a heavy body, or a swarm of them, with planetary velocity, have yet been satisfactorily worked out: the determination of the maximum observed distribution over the earth's surface of masses belonging to a single meteoritic type would be useful, either as a criterion or as a confirmation of a solution of the mechanical problem.

The evidence for and against the natural occurrence, over a large area, of meteoritic masses belonging to a single and well defined type, is thus not without scientific interest: firstly, as throwing light on the possible occurrence within comparatively recent times of large meteoritic showers such as are not known to have been actually observed; and secondly, as bearing on the true relationship of meteorites and shooting stars.

Supposed wide-spread showers in other regions.

The occurrence of wide-spread meteoritic showers has been regarded as established by the distribution of meteoritic masses, not only in the Desert of Atacama, but also in Africa and Mexico.

It is true that masses of meteoric iron, rarely more than one or two hundred pounds in weight, have also been found dispersed in considerable number over the extensive territory of the United States of North America; but it has been as yet impossible, by investigation and comparison of the mineralogical characters of those masses, to obtain any reliable evidence that distant individuals have ever belonged to one meteor.

The evidence relative to a wide distribution in Africa of masses belonging to a single type is extremely slight: when examined it appears to be based solely on the brief statement, made on the authority of Captain

J. E. Alexander,[1] "that there were abundant masses of iron scattered over the surface of a considerable tract of country." In his map the words "much iron" are inscribed close to, and on the east side of, the Great Fish River, in 26° south latitude. But this point is sixty miles from his route as marked on the map, and Alexander gives no description either of the locality or of the mode of occurrence: it is practically certain that he never saw the masses, and that the above information was given to him by a native: in any case, it is not suggestive of a distribution over an extraordinary area. This is confirmed by the reference to the iron made by Captain Alexander in a paper read to the Royal Geographical Society:[2] he states that "there is also *said to be*, to the N.E. of Bethany, near the Great Fish River, a plain covered with large masses of iron, some of which require several men to lift them. I have got specimens of this iron."

Mexican Meteorites.

But the evidence relative to Mexico is of a much more voluminous character, and is deserving of the closest attention. Mexico is remarkable beyond any other part of the earth's surface for the number and magnitude of the masses of meteoric iron found within its borders: it has been generally assumed that wide-spread showers were necessary to the explanation of their occurrence. Professor Lawrence Smith[3] came to the conclusion that masses belonging to a single meteor were distributed over hundreds of miles of country in Northern Mexico, and his conclusion has been generally accepted:[4] Professor Whitney,[5] and also Señor Urquidi,[6] regarded it as possible that a whole series of iron masses, for a distance of more than a thousand miles through Mexico and the United States, were the result of a single fall: Huntington[7] states that the fact of certain masses having been "found in places so remote from each other does not seem to preclude their having belonged to one individual, since the Rochester meteorite was seen to pass over the States of Kansas, Missouri, Illinois, Indiana, Ohio, and is supposed to have passed over Pennsylvania and

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[1] *An Expedition of Dis. Inter. Africa* (*countries of the Great Namaquas, Boschmans and Hill Damaras*), 1838, vol. 2, appendix, p. 272.

[2] *Journ. Roy. Geogr. Soc.*, London, 1838, vol. 8, p. 24.

[3] *Amer. Jour. Sc.*, 1871, ser. 3, vol. 2, p. 338.

[4] *Ibid.*: 1887, ser. 3, vol. 33, p. 116.

[5] *Proc. Cal. Ac. Nat. Sc.*, 1866, vol. 3, part 3, p. 242.

[6] *Bol. de la Soc. Mex. de Geog. y Estad.* Segunda época, 1871, vol. 3, p. 276.

[7] *Proc. Amer. Acad. of Arts and Sciences*, 1888, vol. 24, p. 34.

New York, and thence out to sea, dropping fragments in its course. It therefore is possible that at some remote period an enormous iron meteorite may have passed over the entire breadth of the United States, the main mass reaching Mexico, but large fragments breaking off and falling during its passage across the country : " Professor Barcena[1] is further of opinion that the "peculiar property, difficult of explanation, which the Mexican soil has in attracting the meteoric irons is even noticed at present " (in the attraction of shooting stars).

The following questions thus present themselves for consideration :—

1. What meteoritic falls have been actually observed in Mexico ?
2. In what localities are meteoritic masses said to have been met with ?
3. Is our knowledge of the distribution in these localities at all precise ?
4. Is the climate favourable to the preservation of meteoritic masses ?
5. Are any falls of remote date ?
6. Have any masses been transported from their place of fall ?
7. Had the ancient Mexicans any skill in the transport of heavy blocks ?
8. Had they any respect for meteorites as bodies fallen from the sky ?
9. Is there any evidence of the wide dispersion of masses belonging to a single type ?
10. If so, is the dispersion celestial in origin or due to the action of man ?

1. Meteoritic falls actually observed.

Only the following seven falls are known to have been actually observed :—

November 24th, 1804.	Hacienda de Bocas, State of San Luis Potosi.
January, 1844.	Loma de la Cosina, State of Guanajuato.
June, 1865.	Hacienda d'Avilez, State of Durango.
June 11th, 1878.	Irapuato, State of Guanajuato.
September 17th, 1879.	Tomatlan, State of Jalisco.
June 18th, 1881.	Pacula, State of Hidalgo.
November 27th, 1885.	Mazapil, State of Zacatecas.

With the exception of Mazapil, the fallen bodies have been essentially stony in character ; in the case of Mazapil, the mass consisted of meteoric iron and weighed only about 8 lbs. : in no case were more than three fragments collected. During the same interval of time, larger showers and more numerous falls have been observed within the British Isles, which are comparatively small in area.

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[1] *Proc. Ac. Nat. Sc. Philadelphia*, 1876, p. 126.

Doubtless other meteoritic falls have been observed in Mexico, though the masses have not been preserved: as stated below, the companions of Cortes, for example, are said to have seen a meteorite at Cholula which had fallen on the neighbouring pyramid.

A fireball, probably meteoritic, caused much terror to the Mexicans in the year 1521: "many, after the siege, declared that among other prodigies, they beheld a stream of light of a blood-red colour, coming from the north in the direction of Tepejacac, with a rushing noise like that of a whirlwind, which swept round the district of Tlatelolco, darting out sparkles and flakes of fire, till it shot far into the centre of the lake" (Prescott).

2. Localities in which meteoritic masses have been found.

A statement of the precise localities in which masses, recognised as being of meteoric origin, have been met with is given below: at this stage we need merely observe that the localities are only in the following States (Plate I.):—

I. Coahuila and Nuevo Leon; II. Chihuahua; III. Sinaloa; IV. Durango; V. San Luis Potosi; VI. Zacatecas; VII. Mexico and Morelos; VIII. Oaxaca; IX. Guerrero.

3. The distribution in each locality.

Our knowledge of the distribution of the masses is much more precise for Central and Southern Mexico than for the Northern regions, more especially Coahuila. On the other hand, it is the supposed distribution of meteoric irons in the Bolson de Mapimi, Northern Mexico, that has been largely relied upon as illustrating the occurrence of wide-spread showers. It will be seen, on consideration, that until many years after the publication of the papers of Shepard and Lawrence Smith, no trustworthy information relative to the greater part of that district can have been available, and that any inferences as to wide-spread showers in that region must have been of doubtful value.

The following extracts, from works published at various times during the century, are sufficient to indicate the difficulty which would have been met with, in attempting to get reliable information as to the distribution of meteoritic masses in Northern Mexico:—

(Humboldt,[1] 1811). "The mountainous region called the Bolson de

[1] *Essai politique sur la Nouv. Espagne*, Paris, 1811, 4to ed., vol. 1, pp. 282, 289.

Mapimi has an extent of more than 3,000 square leagues: it is from this district that the Apaches come to attack the colonies of Coahuila and New Biscay: the Bolson de Mapimi is sometimes regarded as unconquered, sometimes as forming part of the Province of New Biscay." "On the north and east of the Province of New Biscay is a strip of uncultivated country, 200 leagues in length, inhabited by Indian warriors and Independents. The border-forts erected for the defence of the colonists are too far apart, and the Indians are much dreaded."

(Ruxton,[1] 1846). "In the fall of last year, and at the present moment (1846), the Indians have been more audacious than ever was known in previous years."

"The ranchos and haciendas in Durango and Chihuahua are each enclosed by a high wall, flanked at the corners by circular bastions loopholed for musketry. The entrance is by a large gate which is closed at night; and on the flat roof of the building, a sentry is constantly posted, day and night." "Between Mapimi and Chihuahua is a large unpeopled tract of country: it once possessed several thriving villages and ranchos, now deserted and in ruins. A road from Mapimi, disused for years and overgrown with grass, leads to Chihuahua through these deserted villages."

(Bartlett,[2] 1852). "The Apaches had been more bold than usual during the spring and summer of 1852, and the whole frontier had suffered from their inroads. Many men had been killed within a few miles of El Paso del Norte, and at the astronomical observatory, 8 miles distant, a man was pierced with arrows while herding the animals within a few rods of the house. No one could venture alone with safety 3 miles from the settlement (El Paso)." "The Comanches pass across the Rio Grande into Mexico in bands of three or four hundred, and penetrate the very heart of Chihuahua; they have passed into Durango and Zacatecas, and have traversed Coahuila and Nuevo Leon. The extent of the depredations and murders committed by them would be appalling, if summed up. The depredations of the Apaches are less serious only because their numbers are less, and they have a more thinly settled country for their operations. These regions, once inhabited by a peaceful and happy population, are now deserted, and the fertile valleys they tilled are reverting to the condition of a wilderness." "The range of the

[1] *Advent. in Mexico and the Rocky Mountains*, by G. F. Ruxton, new ed., 1861, pp. 102, 111, 124.

[2] *Personal Narrative of Explor. in Texas, New Mexico, California, Sonora and Chihuahua*, New York, 1854, vol. 2, pp. 384-6, 396, 455.

Comanches is from the Mexican States alluded to, to the buffalo region north and east of Santa Fé. In the fall and winter season their home is near the Rio Grande, in the Bolson de Mapimi, a vast basin shut in by mountains on the west." "Every small party coming through (to El Paso) from San Antonio had been attacked by the Comanches. At no time had so much alarm been felt." "The Bolson de Mapimi being now (November 1852) in possession of the Comanches and Lipans, who are some thousands strong, it is not considered safe for parties of less than one or two hundred to attempt the journey from Huejuquilla to Parras by the short route across its south-western corner."

In the decade 1860-70 portions of the frontier were still disturbed by Indian hostility.[1]

Under the above circumstances it is obvious that no evidence of wide and plentiful distribution of meteoritic masses in Northern Mexico has ever been available: any inference as to the occurrence of wide-spread falls must have been made merely from the presence of similar masses in a few widely separated localities.

4. Is the climate favourable to the preservation of meteoritic masses?

Like the Desert of Atacama, Mexico is a table-land, but still more lofty and extensive: the table-land gradually slopes downwards in a northerly direction, the capital being 7,600 feet, Durango 6,630 feet, Chihuahua 4,600 feet, and El Paso del Norte 3,800 feet, above the sea-level. Hence the air is exceedingly dry, and the climate unusually favourable to the preservation of meteoric iron. Ward[2] says:—"With a cloudless sky and a brilliantly pure atmosphere, there is a great want of moisture and little luxuriancy of vegetation."

In the discussion of the Atacama meteorites, it was proved that even in the still drier atmosphere of that region, meteoric stones could only escape disintegration for a very limited interval of time.

5. Are any of the falls of remote date?

It will be shown that the history of some of the Mexican masses goes back to very distant times. One was found in an old tomb in the ruins at Casas Grandes: it was wrapped in the same kind of cloth as envelops the bodies found in the adjacent tombs, and must have been buried there

[1] *Encyclop. Britann.*, 1888, vol. 23, p. 820.

[2] *Mexico*, by H. G. Ward, Esq., Her Majesty's Chargé d'Affaires in that country during 1825-7, 2nd ed., London, 1829, vol. 1, p. 8.

efore Mexico was conquered by the Spaniards. In the cleft of another ass is to be seen an ancient chisel of "copper," the material used by the ztecs for their arms, axes, and tools in general. Two small worked speci-en, belonging to the Aztec period and made of meteoric iron, are ex-ibited in the Museum of Mexico.[1] At least one of the masses in ne south of Chihuahua was known long before the latter part of the ixteenth century. Those in the Valley of Toluca were visited about 776. The mass called Descubridora was found before 1780: that of acatecas was examined in 1792: that of Charcas was described in 1804. It is quite possible that with the exception of the small piece which ell at Mazapil in 1885, not a single one of the Mexican iron masses has allen since the Spaniards obtained possession of the country. The masses us seem to be nearly permanent in their material, and may have been ing for any number of centuries in the places where they have been und.

6. *Transportation of masses.*

Some of the masses have been first noticed by scientific men after the moval from their place of fall. The mass already referred to as found a tomb at Casas Grandes was clearly not *in situ:* according to ne account, it is lenticular in shape and 18 inches in diameter; according a later account its weight is such that 26 yoke of oxen were used to aul it to the village. The masses met with at Saltillo, Potosi and erralvo, were discovered in forges in use as anvils: the large masses of an Gregorio, Concepcion, Descubridora, Charcas, Zacatecas and anhuitlan, are all known to have been moved more than once, and for nsiderable distances. The possibility of similar removals in times prior the conquest of Mexico by the Spaniards cannot be entirely disregarded.

7. *Mechanical skill of the ancient Mexicans.*

The following extracts[2] are of interest as proving that before the arrival f the Spaniards there existed, in some parts of Mexico, men capable f moving immense blocks of heavy material when required.

"An immense circular block of carved stone was disinterred in 1790 the great square of Mexico. This colossal fragment, on which ne calendar is engraved, shows that they had the means of settling

[1] *Anales del Museo Nacional de México*, 1882, vol. 2, p. 473.

[2] *History of the Conquest of Mexico*, by W. H. Prescott, London, 1878, pp. 58, 3, 194, 233.

the hours of the day with precision, the periods of the solstices and of the equinoxes, and that of the transit across the zenith of Mexico." "It consists of dark porphyry, and in its original dimensions is computed to have weighed nearly fifty tons. It was transported from the mountains beyond Lake Chalco, a distance of many leagues, over a broken country intersected by water-courses and canals. In crossing a bridge, which traversed one of these latter in the capital, the supports gave way, and the huge mass was precipitated into the water, whence it was with difficulty recovered. The fact that so enormous a fragment of porphyry could be thus safely carried for leagues in the face of such obstacles, and without the aid of cattle, for the Aztecs had no animals of draught, suggests to us no mean ideas of their mechanical skill and of their machinery, and implies a degree of cultivation little inferior to that demanded for the geometrical and astronomical science displayed in the inscriptions on this very stone."

This remarkable stone, which had been buried by the Archbishop of Mexico (1551-9), is now preserved in their National Museum: its weight is estimated at 482 quintals or about 24 tons. We may incidentally remark that Alfredo Chavero[1] in a long series of papers has lately published the results of a most elaborate study of the hieroglyphs upon the stone: he comes to the conclusion that it cannot have been a calendar-stone at all, and was more probably a votive offering to the Sun.

And again—"The fortification was a stone-wall, nine feet in height and twenty in thickness, with a parapet a foot and a half broad. It extended more than two leagues. The work was built of immense blocks of stone, nicely laid together without cement; and the remains still existing, among which are rocks of the whole breadth of the rampart, fully attest its solidity and size. This singular structure marked the limits of Tlascala, and was intended as a barrier against the Mexican invasions."

The pyramid of Cholula may be cited as another illustration of mechanical skill:—"The perpendicular height is 177 feet; the base is 1,423 feet long; it is square and covers about 44 acres: the platform on the truncated summit is more than an acre in area: on the platform stood a sumptuous temple. Travellers still gaze with admiration on it as the most colossal fabric in New Spain."

Humboldt,[2] who gives a figure representing its appearance in 1802, states that the pyramid was already built when the Aztecs reached that

[1] *Anales del Museo Nacional de México*, 1879, vol. 1, p. 353, 1880, vol. 2, p. 3 *et seq.*

[2] *Vue des Cordill. et Mon. d. Peup. indig. de l'Amér.*: Paris, 1810, p. 24.

art of Mexico (A.D. 1190): its construction was attributed by them to ne most ancient time known to their tradition—that of the Toltecs, five enturies before. It is now an almost shapeless hill, with a church at ne top.

Finally, we may cite the statement of Humboldt[1] relative to the ruins of Mitla:—"But what distinguishes the ruins of Mitla from all the other emains of Mexican architecture, is the series of six columns of porphyry, laced in the middle of a large hall and supporting the roof. These olumns, almost the only ones found in the New Continent, show the nfancy of art. They have neither pedestal nor capital. Their height is metres: yet each is formed of a single mass of amphibolic porphyry. he *débris*, accumulated during centuries, conceals the columns to one-hird of their height."

For such a people, a transportation of even the largest of the observed asses of meteoric iron would not have been impossible.

8. *Reverence for meteorites.*

It is well known that in various parts of the Old World, meteorites have en regarded, from the earliest times even to our own day, as objects for verence and worship. The same is true of the New World. As evidence such veneration, it may be mentioned that in the Aztec creed the crea-on of mankind was associated with the fall of a body from the sky. ndrés de Olmos,[2] who went to Mexico immediately after the conquest nd made a careful study of its languages and traditions, states that, not-ithstanding the diversity of worship in different provinces, there was an most universal belief that the goddess Citlalicue gave birth to a *tecpatl* hich fell from the sky to the earth at a place called Chicomoztoc (Seven averns): that from the *tecpatl* came sixteen hundred gods and goddesses: nd that, after a complaint to Citlalicue that there was no one to worship em, mankind was created for their service.

Tecpatl occurs frequently among the Aztec hieroglyphs, and is there sed to indicate one of the days of the month: representations of the arious hieroglyphs, including *tecpatl*, have been given by Manuel Orozco Berra;[3] the hieroglyph *tecpatl* is a figure of the sharp stone which was sed as a knife by the sacrificing priest.

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[1] *Essai politique*, &c., Paris, 1811, vol. 1, p. 264.

[2] *Monarquia Yndiana*, by Torquemada: Sevilla, 1615, vol. 2, pp. 81-2.

[3] *Anales del Museo Nacional de México*, 1880-2, vol. 2, p. 224.

According to Humboldt,[1] the companions of Cortes are said to have seen a meteorite at Cholula, which, enveloped in a cloud of fire, had fallen from the clouds upon the pyramid; and he adds that it had the shape of a toad. I have been unable to trace the original authority for his statement. Humboldt refers also to an ancient tradition of the Aztecs, recorded in a Vatican manuscript of Pedro de los Rios, that the building of the pyramid of Cholula had been begun by Xelhua in commemoration of a Great Flood, which only he and six brother-giants had survived: the gods angered by his audacity sent down fire from heaven, whereupon the building was discontinued and the edifice was dedicated to Quetzalcoatl, God of the Air.

Muñoz Lumbier[2] refers to the Cholula meteorite as having been placed on the summit of the pyramid for the purpose of worship.

It is possible that there has been a confusion of traditions relative to a lightning stroke and a meteoritic fall, and even that a "divine" stone has been assumed by a translator to be of celestial origin.

The respect of the ancient Mexicans for native iron, whether known to be of meteoric origin or not, is illustrated in the careful envelopment and burial of the large mass of iron at Casas Grandes. One of the large Chihuahua masses was believed by the Mexicans of the sixteenth century to have been deposited by their deity for use as a landmark. In other parts of North America, proofs of the same veneration are to be found: in an Indian mound in Oktibbeha County, Mississippi, during an excavation for Indian antiquities, a small piece, weighing 5¼ ozs., was discovered in 1857;[3] this may have been buried merely as a personal relic, for several ear-ornaments and implements, made of meteoric iron, were found in the mounds of Little Miami Valley, Ohio, in 1883.[4] The Brazos mass, weighing 320 lbs., removed to San Antonio in 1836, had been long known to the Comanches. It had been set up as a *fetich*, or object of veneration, at a spot where several converging trails intersected: it was the custom of all who passed by to deposit upon it beads, arrow-heads, tobacco, and other articles as offerings: the Indians "revered it as foreign to the earth and coming from the Great Spirit."[5]

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[1] *Vues des Cordillères et Monuments des Peuples indigènes de l'Amérique*, Paris, 1810. p. 32.

[2] *Los Aerólitos de Chihuahua*, México, 1880, p. 6.

[3] *Amer. Jour. Sc.*, 1857, ser. 2, vol. 24, p. 293.

[4] *Ibid.*, 1887, ser. 3, vol. 33, p. 228.

[5] *Trans. Ac. Sc. of St. Louis*, 1857-60, vol. 1, p. 622. *Amer. Jour. Sc.*, 1884, ser 3, vol. 28, p. 286.

The Iron Creek mass, weighing 386 lbs., removed about 1869, was also 'greatly venerated by the Indians, who made offerings to it of beads, trinkets and knives, before setting out on hunting or warlike expeditions."[1]

Hence it would have been far from surprising if a religious and skilful people, like the Aztecs, had transported meteoritic masses from their original sites for the purpose of worship: the large blocks of stone on Salisbury Plain furnish a good example of the transportation of heavy masses for great distances by a still more ancient race.

9-10. Natural or artificial dispersion of masses belonging to a single type.

In very few cases is there any evidence at all of wide distribution of masses belonging to a single type. The large masses of San Gregorio, Concepcion and Chupaderos, all in Chihuahua, are very similar in their external characters, and probably belong to a single fall: the extreme separation is about 66 miles, but it will be proved that the two former masses have been transported for some distance to their present sites. Masses belonging to a single type, and probably the results of a single fall, have been brought from widely separated places in Coahuila and its neighbourhood; masses belonging to another type have been brought from places in the Valley of Toluca and also at considerable distances therefrom: there is very strong evidence, however, that in these two cases the dispersion has been artificial. In the remaining cases there is nothing suggestive of wide-spread showers.

Tucson, though formerly within the Mexican border, is now in the United States: but the view has been expressed that the masses of iron, long preserved there, are products of a meteor to which various Mexican masses have been supposed to be due. The history and description of the Tucson masses, as already given in a separate paper,[2] are however sufficient to establish the complete independence of the Tucson and Mexican falls.

The history and distribution of the various Mexican masses are given below: it has been necessary to enter into considerable detail, for it will be seen that the identity of a mass, referred to in a given description, can often be established only by attention to some point which in itself is of merely trivial import.

History and distribution of the Mexican meteoritic masses.

In the value of his contributions to a general scientific knowledge of

[1] *Proc. & Trans. Roy. Soc. of Canada*, 1887, vol. 4, sec. 3, p. 97.

[2] *Mineralogical Magazine*, 1890, vol. 9, p. 16.

Mexico, Burkart takes a place next to Humboldt: in particular, his repeated inquiries after Mexican meteorites have had for their result a large addition to our information.[1] Lately Antonio del Castillo, Director of the School of Mines of Mexico, has done a great service, by placing on record a list of the meteoritic masses known to still exist in that country.[2]

It will be convenient here to indicate some of the conclusions, to which we are incidentally led by the following detailed investigation :—

1. The large "Durango" mass, mentioned by Humboldt, inquired after for years by Burkart, and vainly searched for by many people in the course of the century, is undoubtedly identical with one of the Chihuahua masses at present known.

2. The "Durango" mass of Karawinsky was found at the Labor de Guadalupe, a few leagues from Durango City.

3. The "Venagas" mass, mentioned by Lawrence Smith in 1854, but up to the present untraced, is certainly identical with the Descubridora mass.

4. The mass supposed to be near Los Zapotes is identical with that of Zacatecas.

5. The so-called Chalco and Cholula masses are identical with that of Yanhuitlan; and the Misteca fragments are undoubtedly parts of the same.

6. The identity of the locality of the Coahuila masses mentioned by Shepard with that of the masses collected by Butcher, long suspected, is beyond doubt.

7. The situation of the so-called "Sancha Estate" is now determined.

8. The Rio Florido mass is probably identical with that of Concepcion.

We now proceed to the detailed discussion of the meteoritic masses found in the several States.

I. States of Coahuila and Nuevo Leon.

The known meteoric irons of Coahuila may be grouped as follows:—

1. The masses which Shepard designated by the name *Bonanza;*

2. The masses collected by *Dr. Butcher;*

3. Masses brought from *Santa Rosa* (*de Muzquiz*), but of which the previous history is matter of inference;

4. The *Sanchez Estate* mass.

With the above must be considered

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[1] *Neues Jahrb. f. Mineralogie*, 1856, p. 257; 1857, p. 53; 1858, p. 769; 1866, p. 401; 1870, p. 673; 1871, p. 851; 1874, p. 22.

[2] *Catalogue Descriptif des Météorites du Mexique*, Paris, 1889.

5. The *Fort Duncan* mass (from the Texas side of the Rio Grande) : and conveniently also
6. The *Potosi* mass (Nuevo Leon), and
7. The *Cerralvo* mass (Nuevo Leon).

It will be sought to prove that all the masses belong to a single fall, have been brought to Santa Rosa from a district of small area in the Bolson de Mapimi, and have been artificially distributed, chiefly for the use of blacksmiths.

Physical features of the Bolson de Mapimi.

The Coahuila masses have been found in the Bolson de Mapimi, which, as already shown, was long frequented by the Apaches, Comanches and Lipans. The name was formerly given to a large extent of country bounded on the north by the Rio Grande, and having the towns of Huejuquilla, Mapimi and Santa Rosa, on its western, southern and eastern borders, respectively. The following description by Wislizenus will give some idea of its general features as seen from the southern base:—[1]

"Leaving Mapimi our road now led to a very open and level valley, which belongs to the famous Bolson de Mapimi which commences here. To the right of our road, or east, at the distance of from 3 to 5 miles a steep and high mountain-chain of limestone rises, and another chain to our left from 10 to 15 miles. Both chains gradually diverge, but especially the eastern which seems to run towards the north-east and to return thence towards the south-west at an angle, leaving a large *cul de sac* or pouch (Bolson) in the middle, from which form the country has probably received its name. The pouch-like slope of the country extends most likely as far as the Rio Grande. Passing over a ridge on our road, I enjoyed the most distant view over the Bolson de Mapimi. All around us was an immense chaparrál plain, and in the distance of from 15 to 20 miles ahead of us the Rio Nasas, which runs towards the north into the above mentioned pouch, and forms there the large Laguna de Tlagualila (on maps generally called Lake Cayman). Neither the lake nor the northern end of the Bolson was to be seen from my place of observation ; but the outlines of the surrounding mountains, disappearing on the most distant horizon, seemed to extend towards the north to about 80 miles in length, and towards east and west to an average breadth of 30 miles. As to the physical properties of the Bolson, the general impression is that it represents a low, flat, swampy country, and a mere desert, which

[1] *Memoir of a tour to Northern Mexico, connected with Col. Doniphan's Expedition in* 1846-7. [Senate Doc.], Washington, 1848, p. 67.

is but partly true. The soil in the Bolson is less sandy, and better than in the higher country; in the valley of the Nasas, especially, is a black rich soil and most luxuriant vegetation. At Mapimi the elevation was found to be 4,487 feet, at San Sebastian 3,785, at San Lorenzo 3,815, at San Juan 3,775, at El Pozo 3,990, and at Parras 4,987."

1-5. The masses probably belong to a single fall.

The probable singleness of the fall is established by the unity of the rare characters of the masses. When a polished face of a Coahuila iron is etched, the Widmanstätten figures, so common in meteoric irons, are found to be everywhere, or almost everywhere, completely absent: in their place are seen the far less frequent systems of fine and straight parallel lines (called Neumann lines) extending across the etched face; the angles between the different systems, of course, varying with the direction of the section. The etched faces of specimens of the Sanchez Estate, Bonanza, Butcher and Fort Duncan irons, now in the British Museum, are indistinguishable in their features.

Looking to the rarity of such features on the etched faces of meteorites; and to the fact that the above masses have been brought from a region of the earth's surface comparatively small in area; and remembering that no mass belonging to the more common meteoritic type has yet been brought from Coahuila, while none, or at most one, belonging to the Coahuila type have been brought from any other part of Mexico; it is impossible to escape the conclusion that probably all have fallen simultaneously, whether the fall was wide-spread or not.

After investigation of the modes of fracture of meteoric iron, Huntington[1] came to the conclusion that, notwithstanding the similarity of the etched faces, the differences of fracture were such that it was impossible to regard the Sanchez Estate block and those collected by Dr. Butcher as ever having belonged to a single original mass: hence he assigned the Butcher irons to one fall and the Sanchez Estate to another, expressing the view that the latter was a wide-spread one, and was further represented by the mass found at Fort Duncan, and by others found hundreds of miles farther away, at Allen County in Kentucky, and Chattooga County in Georgia. Later observation, however, has shown that the variation of crystalline character in different parts of one block is quite sufficient to prove that the fracture is a discriminating character to which little weight can be attached.

[1] *Proc. Amer. Acad. of Arts and Sciences*, 1888-9, vol. 24, pp. 34, 313.

1-3. The Bonanza, Butcher, and Santa Rosa masses.

The localities of the Bonanza and Butcher masses are identical.

The accounts given relative to the localities of the Bonanza and Butcher masses differ so much from one another that, without a minute comparison of the various statements, a decisive conclusion as to the identity or otherwise of the two localities is impossible: the difficulty is not diminished by the puzzling fact that in none of his papers does the later author make the slightest reference to the descriptions given by the earlier one in the same periodical, although the later expedition was probably a direct result of the account of the earlier visit. As previous discussion has left the identity of the localities uncertain, it is desirable to enter into such detail as will suffice to establish the identity in a decisive manner.

The masses referred to in Charles Upham Shepard's papers[1] had been visited by Major E. M. Hamilton: Shepard's statements are founded, partly on a letter from Professor Forrest Shepherd, who had been recently travelling with Hamilton in Nuevo Leon, and partly on later information derived directly from Major Hamilton himself; Lawrence Smith's accounts[2] are based on descriptions furnished by Dr. H. B. Butcher, who had himself collected several masses, and had transported them to the United States.

The differences in the accounts are in respect of (*a*) the number and sizes of the masses existent at the localities, (*b*) the distance of the localities from Santa Rosa.

(*a.*) *Number and sizes of the masses.*

1. The Bonanza masses:—"In an open space, about one quarter of a mile square, partially overgrown with palmetto palms, might be seen fourteen ponderous masses of native iron, the largest of which rises upwards of four feet above the ground, having the form of a bee-hive — being five feet in diameter where it enters the soil, and into which it descends for an unknown depth. Major Hamilton informed me that he excavated on one of its sides to the distance of 18 inches, without discovering any diminution of its diameter" (Shepherd's letter to Shepard, 1866). "Major Hamilton saw thirteen pieces; twelve of which had never been removed, and one small mass of about seventy-five pounds that had been carried to the village of Santa Rosa. The largest mass

[1] *Amer. Jour. Sc.*, 1866, ser. 2, vol. 42, p. 347; 1867, ser. 2, vol. 43, p. 384.

[2] *Ibid.*, 1869, ser. 2, vol. 47, p. 383; 1876, ser. 3, vol. 12, p. 107.

projects two or two and a half feet above the ground, and is some three feet long and a little less in width. How far it is buried in the earth is unknown. Some of the smaller of them are estimated to weigh between 2 and 3 thousand pounds." (Hamilton's letter to Shepard, 1867.)

2. The Butcher masses :—" I have returned fully successful, and am making preparations to send on the iron. They consist of eight pieces, varying from 290 lbs., which is the smallest, to 654 lbs., which is the largest, making a total of nearly 4,000 lbs. Before the explosion, the weight must have been much greater, as it is not probable that I have secured the whole, and we know some was taken away by the Indians, who thought they found large masses of silver, and carried their specimens to Santa Rosa." (Dr. Butcher, 1868.)

It is difficult to believe that the masses collected by Butcher, varying in weight between 290 and 654 lbs., can have been identical with any of those estimated by Hamilton to weigh at least 2 or 3 thousand pounds. As Butcher remarks, it is improbable that he secured all the specimens ; and indeed it would be easy for some to have escaped attention. Hamilton himself says that the masses were distributed over an area between one and two miles in diameter : in Shepherd's version of Hamilton's statement, the space is stated to be a quarter of a mile square. Butcher says :—" The plain in many places is cut up with deep ravines ; several of the specimens of iron were found among the stones and sand at the bottom of the ravines, and during heavy rains were washed or covered with water. It is, however, only in wet seasons that the water is found remaining in the ravines and depressions of the valley."

The differences in these statements of the number and sizes of the masses, though unsatisfactory, are not themselves sufficient to prove that the localities mentioned by Hamilton and Butcher are distinct.

(*b.*) *Distances from Santa Rosa.*

Shepherd gives a diagram in illustration of Hamilton's route, and the following distances :—" From Santa Rosa westerly to Naciemento (*i.e.* Nacimiento) 40 miles, more or less. From Naciemento westerly or north-westerly about 15 miles to a gap through the mountains called Puerta Santana (*i.e.* Puerto Santa Ana). From the Puerta, northerly for 60 miles, along the valley, past a spring to the termination of the mountain on the left ; and thence around the end of the mountain, passing a second spring, by a north-west route for a distance of about 50 miles towards an apparent junction of the mountains."

This makes the distance from Santa Rosa to be 165 miles. On the

other hand, Butcher estimated the locality visited by himself as about 90 miles from the town.

The difference is, however, quite explicable as due to error of estimation. On what appears to be an excellent map, published by Garcia Cubas, the distance from Santa Rosa to Nacimiento is shown as 22 miles (instead of "40 miles more or less"); while the distance from Nacimiento to Puerto Santa Ana is given to be much less than 15 miles: hence it is clear that the estimated distances given in Shepherd's letter are of little value in establishing a difference of the localities.

Indeed, the indirect and direct statements made to Shepard are themselves very different; for according to the latter, apparently published as a correction of the former, the place was "about thirty or forty miles north of Santa Rosa, but much farther to the west," a statement very difficult to interpret.

(*c.*) *Direction from Santa Rosa : features of the locality.*

Both Hamilton and Butcher travelled into the mountains in a direction north-west of Santa Rosa; and their descriptions of the physical features of the locality itself are almost identical.

(*Shepherd.*) "And thence Major Hamilton travelled along the valley towards an apparent junction of the mountains; and where the valley becomes narrow, to an open space, about one quarter of a mile square, partially overgrown by palmetto palms."

(*Butcher.*) "The spot is in an alluvial valley, or plain, between two ranges of high mountains running parallel with each other, varying in distance from one to three miles."

(*d.*) *Hamilton and Butcher were not original discoverers.*

The existence of masses of iron about 90 miles north-west of Santa Rosa had long been known at that town.

"Meteoric iron is known to exist about 90 miles north-west of Santa Rosa. An American resident of this town, Dr. John Long, called my attention to a piece weighing some 25 lbs. which was then in possession of a Mexican. It is said that the whole surface of the area, embracing about 30 acres of land, where the deposition of this valuable mineral occurs, is covered with blocks of it, of greater or less extent, some containing as much or even more than 36 cubic feet." (Arthur Schott, 1857.)[1]

"According to an oral statement of Professor Posselt, meteoric iron

[1] *Report on the U.S. and Mex. Bound. Survey* (W. H. Emory), 1857, vol. 1, part 2, p. 34.

exists in the vicinity of Santa Rosa: it is partly in large blocks, partly among the rolled stones, over a considerable area." (Wichelhaus, 1863.)[1]

The fragment analysed by Wichelhaus was taken from a specimen which had been placed in the Heidelberg Collection: the mass must have been a very small one, for there are now only 293·6 grams of Santa Rosa iron preserved there.

"Dr. John A. Veatch saw in 1849 a large mass of iron at Santa Rosa, which was then in use as an anvil at a blacksmith's shop, and was informed that many pieces of native iron had been used there for various purposes. The mass which Dr. Veatch saw was of about the size of an ordinary anvil. It was said to have been brought from the mountains north-west of the town." (Letter to Prof. Whitney, 1866.)[2]

"Residents in the vicinity told Major Hamilton (1867) it had only once before been visited by any traveller, and this was fifteen years ago, when an Englishman had been deputed thither, in an official capacity, to determine whether the iron could be applied to any useful purpose." (Shepard, 1867.)

"According to a son of Dr. Long, shortly after 1837 an Indian brought a piece, weighing 10 or 12 lbs., into Santa Rosa, supposing it to be silver, having found it some 90 miles north-west of the town." (Butcher, 1868).

The following is clearly another account of the same incident:—

"One of my guides relates as a fact that at that time (1837) a Lipan Indian was riding one of their small ponies through the valley, when his stirrup struck against one of the masses, causing a ringing sound like silver. He dismounted, and was confirmed in his opinion of silver, and took away a piece, 10 or 12 lbs. in weight, which he carried into Santa Rosa to sell." (Butcher, 1868.)

(*e.*) *Hamilton and Butcher were guided to the same place.*

Hamilton and Butcher both started from Santa Rosa: they went with the specific intention of seeing masses, the existence of which had long been a matter of common report in that town: Butcher, at least, hired guides at Santa Rosa: both entered the mountains in a north-westerly direction. It is unlikely that more than one route through so dangerous a region can have been known to the inhabitants of Santa Rosa at that date; and it would probably be the most natural route, and therefore the one used

[1] *Pogg. Ann.*, 1863, vol. 118, p. 631.

[2] *Proc. Calif. Ac. Nat. Sc.*, 1866, vol. 3, part 3, p. 241.

y the Indians themselves. Further, it is improbable that the inhabitants f Santa Rosa were so venturesome as to depart far from this natural route or the purpose of exploring the Bolson.

In fact, both Hamilton and Butcher seem to suggest that the place was eached by keeping along a particular valley, and Dr. Butcher says dis- nctly that it was near the regular Indian trail:—"I hired eight Mexicans nd two Indians as guides, and started into the mountains, which are istant about 35 miles, and found the iron about 90 miles from Santa osa. As no vehicle could be got into the mountains by the route we ntered, I spent two days in exploring a new road whereby the ox-teams ould bring them out. My party were in considerable danger while in ne mountains, as we were two miles from the regular trail, when some 00 Indians went through with a large number of their stolen horses."

Passages of the Rio Grande in this district.

A route having the characters described by Hamilton and Butcher has very claim to be regarded as a natural one, and would lead to places here the Rio Grande is known to be fordable; and between Presidio del orte and Eagle Pass not many parts of the Rio Grande, to which the rail doubtless led, could be readily crossed by the Indian bands.

Lieutenant Michler,[1] who surveyed this part of the river, reports as llows:—

"From this valley (in the vicinity of Fort Leaton, near Presidio bl Norte), we suddenly enter the range of the Bofecillos Mountains, rough which the river has found or forced a passage, forming extensive pids at its entrance. The cañon of the Bofecillos Mountains is less gged in its character than those met with subsequently. Comanche ss, the most celebrated and frequently used crossing place of the Indians, as found to be just below this Bofecillos Range: here broad, well-beaten ails, lead to the river from both sides. Below the crossing, the river sses through a country varying but little from that which was met with ove. The San Carlos Mountains rise in front to a considerable height. he passage of the river through these mountains is grand and imposing. om the edge of the cañon the river may be seen far below, at a distance great as to reduce it in appearance to a mere thread; and from this ight the roar of the rapids and falls is scarcely perceptible. The stream hemmed in by the cañon for ten miles, and then leaves it with the same

[1] *Rep. on the U.S. and Mex. Bound. Sur.* (W. H. Emory), 1857, vol. 1, part 1, p. , *et seq.*

abruptness that marks its entrance. As the descent of the river by boats was here impracticable, a *détour* was rendered necessary, and the river was again reached at a point some twenty miles below the lower termination of the cañon. It was here found necessary to cross the mule-train from the Mexican side: this was effected, though with considerable difficulty, at one of the usual crossings of the Indians. Near this point, above and below, the country is more open. After passing the Los Chisos Mountains, the survey was carried on with less labour than was previously encountered until we reached the Sierra San Vicente. Through these mountains the river forces its way, forming a cañon that equals the San Carlos in many places both in ruggedness and grandeur. Some sixty feet above the level of the river-bottom is situated the old Presidio San Vicente, long since abandoned and now crumbling to decay. After the Sierra San Vicente was found a country cut up with deep *arroyos*, presenting to the survey almost insurmountable obstacles. Passing these *arroyos* a wild valley, nearly at right angles with the course of the river, preceded the approach to the cañon of Sierra Carmel (Cármen), another of those rocky dungeons in which the Rio Grande is for a time imprisoned. No description can give an idea of the grandeur of the scenery through these mountains. Beyond the Sierra Carmel, the river seemed to pass through an almost interminable succession of mountains: cañon succeeded cañon: the valleys, which alone had afforded some slight chances for rest and refreshment, had become so narrow and devoid of vegetation that it was quite a task to find grass sufficient for the mules." "It was next to an impossibility to approach the river for the next twenty miles of the survey, this section being literally cut up by deep *arroyos;* steep hills covered with rocks of igneous origin, intervene and jut into the water's edge. From the end of this section the country undergoes a great change: the formation is limestone, and the river forces its way through a deep cañon nearly twenty miles in length, its banks being composed of high perpendicular masses of solid rock. *Arroyos* of the same structure, at many places, open into the river; in following its course we had frequently to make *détours* of 25 and 30 miles, in order to advance our work a few hundred feet. Then came the first break in the cañon, and the crossing being fordable, formed an accessible pass for the Indians into Mexico. This ford is known as the Lipan crossing, and the Lipans often visited us here. Afterwards the bed is narrow and hemmed in by continuous and perfect walls of natural masonry, varying from 50 to 300 feet in height. Not unfrequently we had to travel for miles without being able to find a spot on which to land."

Other assumptions would be necessary.

Finally, we may remark that, if the two localities are distinct, it is ecessary to assume that, although both localities were known to guides Santa Rosa, the guides to each locality had no idea that the locality nown to them was distinct from that known to the guides to the other, r there is no record of two localities having been ever mentioned at the wn; and further, that if the two places were on the same Indian trail, amilton was taken by the Santa Rosa guides past the vicinity of the utcher masses, which, though smaller and fewer, were identical in general aracter with those he was going so far to see, and that not one of them as pointed out by a guide or attracted his own attention.

The localities are identical.

From this analysis of the statements it appears that only one conclusion n be arrived at—namely, that the masses visited by Hamilton and utcher were in a single locality; and that the masses brought from time time to Santa Rosa for sale, or to be worked in the smithies, had been ot from the same limited area.

From Butcher's description, it would seem that the locality was near e place now marked in Garcia Cubas' map of Coahuila as the site of a ncho called *San José de las Piedras* (latitude 28° 42′ N., longitude 3° 3′ W. of Mexico City).

4. The Sanchez Estate mass.

This mass, weighing 252 lbs., now in the Smithsonian Institution at ashington, was figured and described by Professor Lawrence Smith 1854-5.[1] The mass had been taken to the United States by Lieutenant . N. Couch (not Gouch), who made some explorations in Northern exico during the winter 1852-3[2]: he found the mass in use as an anvil Saltillo: "it was said to have come from the Sancha Estate, some 50 60 miles from Santa Rosa: various accounts were given of the precise cality, but none seemed very satisfactory: it is stated that where this ass was found there are many others of enormous size." Genth also alysed a fragment of this mass, but under a misapprehension makes the istake of saying that it had been brought from New Mexico:[3] probably e label had been inscribed *N. Mexico*.

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[1] *Amer. Jour. Sc.*, 1855, ser. 2, vol. 19, p. 160.

[2] *Smithsonian Report for* 1854, pp. 15, 86.

[3] *Ibid.*, p. 15; *Amer. Jour. Sc.*, 1854, ser. 2, vol. 17, p. 239.

We have pointed out above that Dr. Veatch had seen a mass of meteoric iron in use as an anvil at Santa Rosa in 1849; and that it was then known at Santa Rosa that masses of large size were to be got from the mountains northwest of the town. Saltillo is a town having now 26,000 inhabitants, and is more than a hundred miles south of Santa Rosa, which has a present population of 3,350.

Cost of anvils in Northern Mexico.

Before the introduction of railways, anvils and other heavy goods which needed to be imported, would cost large sums for carriage to places so difficult of access from the coast as the towns of Northern Mexico.

The difficulty of obtaining iron at places like Santa Rosa in the early part of the century, is well illustrated by the experience of Phillips who required some cast-iron pipes for the pumping engines at Catorce a place comparatively easy of access from Santa Rosa and Saltillo. There was only one route north of Jalapa by which a carriage could ascend to the table-land from the east coast, and that was by way of Monterey and Saltillo: by this route Phillips had conveyed the pumping engines themselves to Catorce, exactly twelve months being necessary for their transport from London. Unluckily, cast-iron pipes for use with the engines had been forgotten, and Phillips learned at Catorce that the nearest iron-foundry was at Cincinnati on the Mississippi. To get the pipes Phillips left Catorce for Cincinnati in November 1824, received there the last of the castings in May 1825, and spent from May 1825 to February and March 1826 in transporting them to Catorce.[1]

An anvil would thus be comparatively cheap in Northern Mexico, if the distance of transport could be reduced to two or three hundred miles and we might expect that the blacksmiths within a considerable distance from Santa Rosa would be supplied from that town, so long as portable masses of meteoric iron were obtainable.

The carriage of a meteoritic anvil from Santa Rosa to the other towns of Northern Mexico would be a trivial matter, compared with the trouble and the danger from Indians incurred during the transport of the mass to Santa Rosa itself.

Again, the greater the distance from Santa Rosa to which the anvil was carried, the less accurately would the position of the original locality be known; the estimates of distance given by Hamilton are a sufficient proof that no stress can be laid on the difference between the "six

[1] *Mexico*, by H. G. Ward, 2nd ed., 1829, vol. 2, p. 417.

lles" stated at Saltillo and the "ninety miles" stated at Santa Rosa: ile the statement that "where this mass was found there are many ners of enormous size" distinctly points to the locality already known to e inhabitants of Santa Rosa.

Situation of the Sanchez Estate.

The only difficulty is suggested by the mention of what appears to be precise definition of locality, namely "Sancha Estate." Burkart long o pointed out that *Sancha* was not a Mexican name, and must certainly ve been mentioned in mistake: he suggested the possibility of the rrect name being *Sanchez;* but no one has hitherto been able to scover to what the name Sancha or Sanchez Estate can have referred.

The following extracts suggest an interpretation:—

"San Lorenzo is a town of about 1,000 inhabitants. Most of the perty belongs to Señor Sanchez, a rich Mexican, who received us well d seemed to be favourable to the Americans." (Wislizenus, 1846-7.)[1]

Soon after leaving we saw through an opening in the hills on our left, out a mile distant, the hacienda of Patos. This place is the property Don Jacobo Sanchez, and is said to be the finest in the State of ahuila. This gentleman is said to be the owner of three quarters of the ded property in the State, including several large and valuable ciendas, well stocked with cattle, mules and horses. He has lost large mbers by the Indians; and, I am told, has made a claim on the United ates for a million and a half of dollars as an indemnification for these sses. The lands of Don Jacobo extend in a continuous line more than hundred miles." (Bartlett, 1852.)[2]

Patos is 36 miles west of Saltillo: both Patos and San Lorenzo are on highway between that town and Chihuahua City.

At the time of Couch's visit (1852-3), the Sanchez Estate would thus be ll known at Saltillo; and an inhabitant of that town might be pardoned r treating the term Sanchez Estate as synonymous with the State of ahuila itself: even if the blacksmith had got the mass from someone ployed on the Sanchez Estate, there would still remain the practical rtainty that the individual was one who had business relations with nta Rosa, a town through which passed considerable traffic between ltillo and Texas, by way of Eagle Pass, on the Rio Grande.

It may thus be inferred with considerable approach to certainty that the

[1] *Lib. cit.*, p. 70.

[2] *Lib. cit.*, vol. 2, p. 492.

Sanchez Estate mass had originally been found in the locality afterwar visited and described by Hamilton and Butcher.

5. The Fort Duncan mass.

This mass, weighing 97¼ lbs., was found in 1882 by Mr. Cusick whi stationed at Fort Duncan, Texas; Fort Duncan is 140 miles east of th locality specified by Dr. Butcher. Cusick[1] says:—

"I was returning to the garrison from a short trip in the vicinity whe I casually noticed a round-looking boulder that seemed to have a metall appearance. I had it brought to the fort by one of the privates, who foun the task not an easy one. The mass was on the land of a Mr. Wieste o an ancient terrace on the American side of the Rio Grande."

Hidden, to whom we owe the description of the mass, regards as representing a distinct fall, but Huntington,[2] pointing out th insufficiency of his reasons, holds that the mass is an outlying member of wide-spread shower, of which the masses to the north-west of Santa Ros formed part. No one can compare two large etched faces belonging to th Fort Duncan and Coahuila irons without concluding that the identity character is complete, and that the rarity of the character points to probable simultaneity of fall; but it by no means follows that the fall wa naturally wide-spread. Masses belonging to the Coahuila fall have bee known, as already explained, since 1837 or soon after, so that the Fo Duncan mass, if really due to the same meteor, must have already had minimum terrestrial existence of nearly half a century before it was foun by Cusick: it is portable, for the weight is comparatively small. We hav seen that much larger masses were long ago dispersed from Santa Rosa greater distances than Eagle Pass, though in the opposite direction, for u as anvils. Further, as already remarked, Santa Rosa was a town throug which passed much traffic from the eastern side of the Mexican tabl land to Texas: the Eagle Pass, where Fort Duncan is situated, was th place where the river was crossed.

It is not at all impossible that the Fort Duncan mass was carri across the river by Indians or Mexicans for sale or use in Texas; w acquired, and afterwards forgotten or thrown away, by a predecessor of M Wieste; and eventually re-discovered by Cusick.

(6 and 7.) The Nuevo Leon masses.

We have said that masses from the north-west of Santa Rosa may

[1] *Amer. Jour. Sc.*, 1886, ser. 3, vol. 32, p. 304.

[2] *Ibid.*: 1887, ser. 3, vol. 33, p. 115.

ooked for in the smithies for considerable distances round that town. In act, two anvils of meteoric iron have been seen in Nuevo Leon, within asy reach of Saltillo: still they have not been scientifically examined, and ay possibly not be identical in character with those of Coahuila.

The first was mentioned in 1856 to Shepard by McDermot,[1] who had een an anvil of meteoric iron in use at Cerralvo, District of Oriente, uevo Leon, in 1847: he likened it in general appearance to the Orange iver mass, which weighed three hundredweight, and was then under spection by him. The carriage from Saltillo to Cerralvo would be ownhill, and would present no practical difficulty.

The second was seen by Weidner at the hacienda of Potosi, District of aleana, Nuevo Leon: he estimated it to weigh about 200 lbs., and said at the shape was that of a quadrangular pyramid: it was mentioned by im in 1870.[2] There is a highway between Saltillo and the hacienda of otosi, and the distance is about 70 miles: Potosi is also within easy reach f Catorce where meteoric iron has likewise been found.

Both masses have since been lost sight of.

The Santa Rosa meteor of 1837.

Lawrence Smith[3] published the following detailed account of a meteor hich had been observed at Santa Rosa in 1837:—

"In a letter dated September 8th, 1868, Dr. Butcher writes, from formation received from the son of Dr. Long, who had resided many ears at Santa Rosa, that in the fall of the year 1837 there appeared over e town a most brilliant meteor, having a north-west direction. He escribes it as most beautiful, lighting up the whole horizon, with a trail brilliant light following in its progress. Shortly after its disappearance nong the distant mountains, they heard a rumbling sound, immediately llowed by a tremendous explosion. From the report, he thought it fell nd exploded as it reached the earth, somewhere between Santa Rosa and ie mountains, a distance of some thirty-five miles; and the next day he arted with friends to examine the route, hoping to find it. After two ays' severe and rough riding they abandoned the search and returned to wn. Shortly afterwards an Indian brought a piece (of meteoric iron) eighing ten or twelve pounds into Santa Rosa, supposing it to be silver,

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[1] *Amer. Jour. Sc.*, 1856, ser. 2, vol. 21, p. 216.

[2] *Neues Jahrbuch für Min.*, 1871, p. 854; *Catalogue Descriptif des Météorites du Mexique*, par Castillo, Paris, 1889, p. 9.

[3] *Amer. Jour. Sci*, 1869, ser. 2, vol. 47, p. 384.

having found it some ninety miles north-west of the town, being in the same direction in which Dr. Long and his friends had been exploring, the doctor having been deceived as to distance, he only going to the base of the mountains, instead of crossing it and then following the valley for some forty miles further."

Though Long's description points to a meteoritic fall at a place north-west of Santa Rosa, it cannot be legitimately assumed with Long and Butcher that the fall must be identical with that to which the meteoric iron found in a north-west direction from the town was due. If such identity could have been assumed, it would have sufficed to establish that the masses brought from Sanchez Estate, Fort Duncan, Potosi, and Cerralvo, were not parts of a wide-spread fall, but had been either transported to those places, or had belonged to distinct meteors.

Chemical analyses of the Coahuila masses.

The following results have been obtained on analysis of fragments of the Coahuila masses :—

	Sanchez Estate.			Near Santa Rosa.				Fort Duncan.
	"New Mexico," Genth,[1] 1854. S.G. 8·130.		Smith,[2] 1854-5. S.G. 7·81.	Wichelhaus,[3] 1863. S.G. —.	"Bonanza Iron," Shepard,[4] 1867. S.G. 7·825.	"Butcher Iron." Smith,[5] 1869. S.G. 7·692.	Lupton,[6] 1885. S.G. —.	Mackintosh,[7] 1886. S.G. 7·522.
	I.	II.						
Iron ..	96·17	95·92	95·82	96·07	97·9	92·95	91·86	94·90
Nickel ..	3·07	3·57	3·18	3·26	2·1	6·62	7·42	4·87 by diff.
Cobalt ..	0·42		0·35	0·55		0·48	0·50	
Phosphorus	..	..	0·24	1·05		0·02	0·27	0·23
Residue ..	..	0·57	..	..		..	..	..
	99·66	100·06	99·59	100·93	100·00	100·07	100·05	100·00

Notwithstanding the numerical differences in the above results, Lawrence Smith was quite prepared to recognise the chemical identity of the Sanchez Estate and Butcher irons, and said (1869) that the separation of the iron and nickel in his analysis (1854-5) of the former was probably imperfect

[1] *Amer. Jour. Sc.*, 1854, ser. 2, vol. 17, p. 239.
[2] *Ibid.*, 1855, ser. 2, vol. 19, p. 160.
[3] *Pogg. Ann.*, 1863, vol. 118, p. 631.
[4] *Amer. Jour. Sc.*, 1867, ser. 2, vol. 43, p. 385.
[5] *Ibid.* 1869, ser. 2, vol. 47, p. 383.
[6] *Ibid.*, 1885, ser. 3, vol. 29, p. 232.
[7] *Ibid.*, 1886, ser. 3, vol. 32, p. 304.

Literature relative to other characters of the Coahuila masses.

In addition to the literature already cited we may mention the papers by Lawrence Smith, on the occurrence of daubréelite, *Amer. Jour. Sc.*, 1876, ser. 3, vol. 12, p. 107; and of a nodule of chromite, *Ibid.*, 1881, ser. 3, vol. 21, p. 461; and those of Brezina on the intergrowth of troilite and daubréelite, on the Reichenbach lamellæ, *Sitzungsb. Ak. d. Wiss. Wien*, 1881, vol. 83, div. 1, p. 476, and on natural planes of separation, *Ibid.*, 1882, vol. 84, div. 1, p. 282.

II. State of Chihuahua.

The meteoric irons of Chihuahua, mentioned in literature, belong to one or other of the following:—

1. *The Casas Grandes mass.*
2. *A mass exhibited in 1876 at the United States International Exhibition.*
3. *The group between Presidio del Principe and Cuchillo Parado.*
4. *The group near Huejuquilla or Jimenez.*

1. The Casas Grandes mass.

Casas Grandes, or Casas Grandes de Malintzin, is the name given to an ancient town and fortress, which commanded the last passage from the North to the Mexican table-land: it is situated in the District of Galeana, and is 125 miles, in direct line, south-west of El Paso del Norte.

From the accounts given by Márcos de Niza, Coronado, Espejo and others, it is well established that at the time of the conquest of Mexico by the Spaniards, in the sixteenth century, the country was inhabited in the fertile valleys, to districts far north of Santa Fé, by Indians who had attained to a comparatively high degree of civilisation, were given to agriculture, were clothed with woven fabric, and lived in large towns consisting of houses which were several stories in height and were built of sun-dried brick. The Valley of Mexico itself is known to have been peopled from the North; and it has been supposed that extensive ruins, still existing between the Valley of Mexico and the country north of the Rio Grande, indicate places at which there were prolonged halts during the migration southwards.

One of these ancient relics is at Casas Grandes de Malintzin.

The first mention of the discovery of a mass of meteoric iron among the ruins at Casas Grandes was made by Tarayre,[1] who reported in 1867 as follows:—

[1] *Archives de la Commission Scientifique du Mexique*, Paris, 1867, vol. 3, p. 248.

"A very important discovery has been made in the great temple o Casas Grandes by Müller, the Director of the Mint of Chihuahua. A excavation, made in one of the chambers of the labyrinth, brough to light, at a small depth, a lenticular mass of meteoric iron, 5 centimetres in diameter, wrapped with care in cloths, similar to thos which enshroud the ancient corpses in the tombs of the same locality The neighbouring tombs are chambers built of masonry: the horizonta section being an ellipse with diameters of 1·5 and 1 metres, and th height 1 metre. In each case the body is seated on the base of the tomb and has the knees raised: it is enveloped in cloth made of fibres, whicl recall those of the agave; and around it are deposited objects whicl belonged to the deceased when alive, such as necklaces, collars, bracelets and pottery."

Another account was given in 1873 by Mr. M. Pierson,[1] United State Vice-Consul at El Paso del Norte, from which the following i extracted:—

"Some three or four years since, a party of the inhabitants of the tow of Casas Grandes, as a matter of curious speculation, commence excavating in the old ruins there. One more fortunate than the other drifted into a large room, in the middle of which there appeared a kind o tomb made of adobe-brick. Renewing his excavations, he found a larg mass of meteoric iron in the middle of the tomb, carefully and curiously wrapped with a kind of coarse linen. Twenty-six yoke of oxen were mustered, and as many or more strong log-chains, and the meteorite wa hauled to the town of Casas Grandes. It measures 2 feet 6 inches square, and is supposed to weigh 5,000 lbs."

Until a more complete scientific examination of the Mexican meteorites has been made, it will be impossible to say from what locality this mass may have been transported by the ancient inhabitants of Casas Grandes.

The Casas Grandes mass has not been heard of since the date o Pierson's letter: on inquiry at El Paso, I learn that Pierson is now dead and that there is no remembrance in that town of the circumstance recorded by him.

The description given by Pierson would not be inappropriate to the mass next mentioned.

2. A mass exhibited in 1876 at the United States International Exhibition.

An uncut block of meteoric iron, estimated to weigh about 4,000 lbs., is

[1] *Smithsonian Rep. for* 1873, p. 419.

preserved at Washington, in the United States National Museum. Dr. F. W. Clarke recalls that it was exhibited among the Mexican minerals in the United States International Exhibition of 1876, and was said to have been brought from the State of Chihuahua.[1] I am indebted to Dr. Clarke for a photograph showing at once this Chihuahua mass and the ring-shaped one from Tucson: by measurement of the photograph and comparison with the known dimensions of the latter mass, it follows that the former, a roundish block, is about 28 inches wide and 38 inches high.

Its history previous to 1876 is as yet untraced.

Professor Barcena, while at Philadelphia as Commissioner for the Mexican part of the Exhibition, read a paper before the Academy of Sciences relative to the Mexican Meteorites: he made no reference either to the Casas Grandes mass or to the one then being exhibited in Philadelphia, and this is difficult to account for unless the two masses were regarded by him as well known to be identical. Still it is unsafe to place much reliance on negative evidence, for no direct reference was made by him to the existence of the immense San Gregorio mass.

The mass cannot have belonged to the Presidio del Principe group; for, as will be seen below, the remarks of Professor Barcena implied that up to 1876 none of the group had been removed from the locality.

The only other large Mexican mass, mentioned in literature but now unaccounted for, is that of Rio Florido; but, as shown below, there are grave doubts as to whether the Rio Florido mass had ever a real existence as distinct from that of Concepcion.

3. The group between Presidio del Principe and Cuchillo Parado.

All that is known of this group is the following:—

Cornejo[2] (1869-70) says:—"A mass of meteoric iron was seen by José Salazar Ilarregui between Cuchillo Parado and Presidio del Principe: it attracted one pole of a magnet and repelled the other: in this place are numerous other masses of smaller size."

Mention was also made of them, in 1876, by Professor Mariano Barcena[3]:—

"Meteoric irons of various dimensions are found in the vicinity of the

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[1] *U.S. Centennial Commission. International Exhibition*, 1876. *Reports and Awards*. 1889, Washington, vol. 3, group 1, p. 369.

[2] *La Naturaleza*, 1869-70, vol. 1, p. 256.

[3] *Proc. Ac. Nat. Sc. Philadelphia*, 1876, p. 122.

Presidio del Principe, in the State of Chihuahua: the inhabitants of that State have promised to send some of the masses to the city of Mexico."

It may be observed that José Salazar Ilarregui (or Y Larregui) was in 1854 the Mexican Commissioner for the Survey of the United States and Mexican Boundary.[1]

Presidio del Principe is not shown in the latest maps; but in older maps, for instance Humboldt's, it is placed 45 miles directly north of Chihuahua City, and thus in the same parallel of latitude as Cuchillo Parado, from which it is distant about 100 miles in a westerly direction.

4. The Huejuquilla or Jimenez group.

We may incidentally mention that the iron of this group was known at the beginning of the present century as "Durango iron," and that one of the masses was described by Humboldt, through a misunderstanding of the term, as being near Durango City: this point will be established later.

Huejuquilla, the nearest town to the largest members of this group, is the capital of the District of Jimenez. According to Bartlett,[2] though the name of the town, as given on the maps, was already (1852) Jimenez (after the Mexican patriot of that name), the town was only spoken of in the neighbourhood by its old Indian title, pronounced as Wa-hu-ke-yah: in literature the word is met with in various forms, *e.g.* Huajuquillo, Huejoquillo, Huexuquilla, Huejuquilla, Hejuquilla, Haxuquilla, Guajuquilla and Guayuquilla. There is now at the town a station called Jimenez, belonging to the Mexican Central Railway, and the old name may possibly fall into disuse; but as the old Indian title is used in all the references quoted in the present paper, it will be convenient to employ it throughout, and to select the form *Huejuquilla* adopted by the Mexican Postal Authorities.

The masses are the most wide-spread of any recognised group, and the wide dispersion is generally accepted as a natural one: the history of the masses thus requires minute consideration, if we are to get a reliable estimate of the maximum observed distance of dispersion for a single meteoritic fall.

The following, except that of Rio Florido, are known to still exist:—

a. A large mass now at the hacienda of San Gregorio.

b. A large mass now at the hacienda of Concepcion.

c. A large mass said to have been seen many years since at Rio Florido.

d. Two large masses now at the rancho or hacienda of Chupaderos.

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[1] *Rep. on the U.S. and Mex. Bound. Survey* (W. H. Emory), 1857, vol. 1, part 1, p. 35.

[2] *Lib. cit.*, vol. 2, p. 453.

e. A small fragment brought from Sierra Blanca.
f. A small fragment brought from the rancho of Tule.

Sizes of the above masses.

	Length.	Breadth.	Height.	Estimated Weight.
	Metres.	Metres.	Metres.	Kilograms
Chupaderos (*a*) ...	2·5	2	0·4	15,600
,, (*b*) ...	2·15	1·1	0·5	9,290
Concepcion ...	1	1	0·4	3,130
San Gregorio	Conical: diam. of base 1·2		1	11,560
Rio Florido ..	Said to be about half the size of Concepcion			
Sierra Blanca ...	Small fragment			
Tule	Small fragment			

From Chupaderos to San Gregorio in direct line is 66 miles: Tule is more remote from Chupaderos being 42 miles farther away beyond San Gregorio.

Do the masses belong to a single fall?

We know as yet very little of the figures produced by etching polished faces of these masses: the information, so far as it goes, is not favourable to the unity of the fall, for though a minute fragment of the Concepcion mass experimented upon is said to yield no Widmanstätten ures, while on the other hand the San Gregorio, Sierra Blanca and Durango " fragments present a very definite octahedral structure,[1] it has n granted that a satisfactory specimen of the Concepcion mass has not been available for the purpose of scientific examination.

Large masses of meteoric iron are so rare, however, that it is difficult to eve that four of the largest masses of meteoric iron yet found on the th's surface can have fallen within this limited district at different es; and the external appearances of the masses, as shown in the ellent photographs kindly sent me by Don Antonio del Castillo, are so y similar, owing to the presence of numerous enclosures of troilite, that lingering doubt as to the singleness of the fall must disappear.

as pointed out later, the evidence relative to the small Tule fragment is very unsatisfactory character, and can be allowed little weight.

[1] *Beschreibung und Eintheilung der Meteoriten zu Berlin* (Rose); 1864, p. 64: *Die eoriten-Sammlung in Wien* (Brezina); 1885, p. 71: *Proc. Amer. Ac. of Arts and nces*, 1888, vol. 24, p. 35.

The region near Huejuquilla, Concepcion and San Gregorio is favourable to transport.

Ruxton[1] says:—"The first day's march from Durango led through a wild uncultivated country (1846), with large plains of excellent pasture, but not a symptom of cultivation." Two days later, his march was "to the rancho of Yerbaniz, through the same uncultivated plains, surrounded by sierras, and passing by a ridge from one into another, each being as like the other as twins. For a thousand miles the aspect of these plains never varied, and the sketch of the plain of Los Sauces would answer for the plain of El Paso, and every intermediate one between Durango and New Mexico." "The plains, generally 10 to 20 miles in width, are divided from each other by an elevated ridge, but there is no perceptible difference in the elevation of them from Chihuahua to El Paso. The road is level except in crossing these ridges."

Having regard to the mountainous character of the region on the west of the table-land, and the few crossing places on the Rio Grande, it is seen that the above route would be one naturally selected for the traffic between Mexico City and the provinces to the extreme north of New Spain. This traffic was already a large one at the beginning of the present century: Humboldt[2] says:—"Thousands of mules arrive every week at Mexico City from Chihuahua and Durango, carrying silver, leather, soap, a little wine from El Paso del Norte, and grain."

Between Rio Florido and Santa Rosalia, two places on this line of traffic, the usual route was by way of Concepcion, El Valle de San Bartolomé (or Allende), Santa Cruz, and Rio del Parral: another road, instead of passing through El Valle de San Bartolomé, went through Huejuquilla, but was less used. As the latter route was taken by Bartlett for his caravan, the two roads cannot have been very unequal as regards facility for transport: probably the former was generally taken as passing through the important town of El Valle. At the present time there is a cart-road between Chupaderos, Huejuquilla and El Valle. (Plate II.)

The country thus presents no obstacle to the transport of masses from the neighbourhood of Huejuquilla to either Concepcion or San Gregorio.

A. The San Gregorio mass.

The existence of native iron near Huejuquilla has long been known.

Relative to the masses now at Chupaderos, Castillo in his list of existing

[1] *Lib. cit.*, pp. 108-9, 162.
[2] *Essai cit.*, vol. 2, p. 689.

exican meteorites writes as follows:—"According to the history of ilip II., the discovery was made in 1581 by the explorer Antonio Espejo." On investigation, however, it appears that only a single pedition was made by Espejo, and that he did not start off from Valle de San Bartolomé till Nov. 10th, 1582; further, in the report of s expedition, he makes no mention of any masses of iron, and, as followed the course of the river Conchos, it is unlikely that he was ever the immediate neighbourhood of Chupaderos itself.[1]

As there appeared to be some mistake, the statement relied upon Castillo was searched for in various histories, and at last found in the "Historia de Felipe Segundo, Rey de España," by Luis Cabrera de rdoba.[2] The following is a literal translation of the passage:—

"Francisco Vasquez Coronado was sent by the Viceroy, in the year 544, with a large number of attendants and horses, and made a ief survey (of New Mexico); but not so Friar Márcos de Niza, who ved as guide, for he entered upon the conversion of the Indians so dly that he was put to death, as was discovered afterwards. Up to the ar 1581, no further attempt to conquer the region was made by e inhabitants of New Spain: Don Lorenzo Xuarez de Mendoza, Count of ruña, the Viceroy, then made a beginning by sending Francisco squez Chamuscado with soldiers and friars of the Franciscan Order: as e friars were unwilling to retire with the soldiers, and persisted in reaching, they were put to death by the barbarians. In this year Espejo, nd afterwards Castaño, and Captain Francisco de Leiva Bonilla, went pon discovery without (the requisite) license: the last mentioned as followed for a hundred leagues by Captain Don Pedro de Cazorla, who the time was acting as governor, and he was ordered not to enter New exico under penalty of being denounced as a traitor. So great was the esire that the King should permit this conquest to be made, that any knightly claimants offered their lives and estates with Christian al. * * * By resolution of his Majesty, on the recommendation of ne Viceroy, the commission was granted to Don Juan de Oñate with ne title of Adelantado. * * * They reached the farthest villages n the borders of New Biscay, where there is a tradition of the ndians that, when they were coming from New Mexico to people ne Old, their deity in the form of an aged woman placed there a

[1] *Hakluyt's Collection of the Early Voyages, Travels and Discoveries of the English Nation*, London, new ed., 1810, vol. 3, p. 457.

[2] Madrid, 1619, lib. 13, p. 1163: also *Edicion publicada de Real orden*, Madrid, 876-7, vol. 2, p. 677.

remarkable landmark of seemingly more than 800 quintals (hundredweight) of iron, whereupon some returned to their mother-country and the rest went on to people New Spain. And, for their boundary and peace, they were divided by this wondrous landmark, set up in a desert, in latitude 27½ degrees, as lustrous as refined silver. The Adelantado entered with 80 carts, many kinds of grain and seed, and splendid soldiers, some unmarried, and others married and with families: they marched with great toil, not knowing the proper roads to take; and at the end of seven months they reached the province they were making for."

According to the latest maps Huejuquilla is in latitude 27° 10′, so that there can be no doubt that one of the masses of the Huejuquilla group is here referred to.

Owing to the want of clearness of the above statement, it would be easy to make the wrong inference that the iron was discovered in the year 1581 by Espejo and Oñate.

The Expedition of Espejo.

A more precise account of the course of events, however, is the following, obtained from the report of Espejo's expedition published in 1586:—

Friar Agustin Ruiz, who was living at El Valle de San Bartolomé, having heard of the existence of other peoples farther north, set out in 1581 with two other friars and eight soldiers to convert the Indians: they reached the region since called New Mexico, and shortly afterwards one of the friars was put to death: the soldiers refused to go farther and decided to return; Ruiz and his companion, being unwilling to accompany them, were left behind. On the return of the soldiers to El Valle de San Bartolomé, the friars there were anxious to send relief to the two brethren left behind; and Espejo, a rich inhabitant of Mexico, and a native of Cordova, who happened to be then at the mines of Santa Barbola (*sic*) or Barbora (*sic*), agreed to take charge of the expedition: having obtained the requisite license, he set off on Nov. 10th, 1582, from El Valle de San Bartolomé "with 115 horses and mules, much arms and ammunition and some attendants." The friars had been put to death before the arrival of the expedition: Espejo eventually returned in July 1583, and an account of his journey was published at Madrid in 1586.

The Expedition of Oñate.

But the expedition made by Don Juan de Oñate was a totally different

; for he set forth, many years afterwards, not to inspect, but to obtain
session of and colonise the new province. According to a letter, written
Tribaldus Toletus[1] in 1605, Don Juan left Old Mexico "in the year 1599
n an armie and carriages of five thousand men, in which number boyes,
nen, young men and souldiers are included. He carried also great store
ituals with him, stockes of sheepe and goates, herdes of oxen, and all
gs necessarie for life, also horses and armour and other things which
hese kinds of expeditions ought to be provided."
s we have already seen that Don Juan marched slowly and was seven
ths on his journey, his arrival at the iron-landmark, if the letter
ribaldus Toletus be correct, may have been either in 1599 or 1600,
more probably in the latter year.

Inscription on the Concepcion mass.

the great colonising expedition of Oñate had really passed the
landmark in the year 1600, it would have been probable that
landmark was really the Concepcion mass, and another possible
anation could have been given of some marks still visible on that

rquidi,[2] the owner of the hacienda of Concepcion, says (1871):—
Among the various marks, there is an inscription, made with some
ty and regularity, saying, "A. 1600."
artlett,[3] who saw the mass in 1852, says:—
On the top, which is quite smooth, is an inscription bearing the date
0; but I was unable to make out a single word of it, so much has it
defaced by hammering and the addition of many crosses. It is said
the inscription gave some account of the removal."
has since been established, as shown later, that the Concepcion mass
transported a distance of many leagues to the vicinity of that hacienda
9th April, 1780: hence it is conceivable that the inscription might
been a commemoration, not of the removal, but of the passage of
specimen by the expedition of Oñate in the year 1600: the "nicety
regularity" of the inscription are suggestive of the industry and
ful workmanship so important an expedition would have had at its
mand: in any case the inscription was probably made before the

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[1] *Purchas his Pilgrimes in five bookes, &c.*, London, 1625. Fourth part, The
th booke, chap. III., pp. 1565-7.
[2] *Boletin de la Sociedad Mexicana de Geog. y Estad.* Segunda época, México,
, vol. 3, p. 275.
[3] *Lib. cit.*, vol. 2, p. 457.

removal in 1780, otherwise the removal itself would not have bee forgotten so soon as was actually the case.

Such a connection between the Concepcion mass and the expedition o Oñate has already, I find, been independently suggested by Muño Lumbier,[1] a copy of whose rare paper I owe to the kindness of Castillo we shall see, however, that the suggestion, though apparently a natura one, is not well founded. The list of the Mexican meteorites was pub lished by Castillo when at Paris far away from his own library: doubtles his reference to Espejo was a trick of memory, and he was intending t quote from the paper of his former pupil, Muñoz Lumbier, in which th extract from Luis Cabrera de Cordoba's History of Philip the Second i given.

The date of Oñate's expedition.

There is an extraordinary difficulty, however, in ascertaining the real dat of departure of the colonising expedition of Don Juan de Oñate. Ludovicu Tribaldus Toletus, whose letter is dated so soon afterwards as 1605, give the year 1599 on the basis of a manuscript volume of Andrew Garci Cespedes, "who hath not obtained leave to publish it, for they will not hav these things particularly to come to light." Luis Cabrera de Cordoba, als a contemporary (1559-1623), with access to important documents, thoug giving, as we have seen, minute details of the expedition, makes n mention of the year of its departure. According to the manuscripts o Padre Geronimo de Zarate Salmeron,[2] whose journal was made public i 1629, Don Juan de Oñate set out from Mexico City to New Mexic in 1596, and in 1599 started from New Mexico on an expedition farthe north, in search of the reported city of Quivira. The years 1591, 1595 1598, have also been accepted for the date of his departure from the Cit of Mexico. On the other hand, the petition of Don Juan to the King o Spain for permission to colonise New Mexico is said to have been dated a late as 21st September, 1595: the decree of the King confirmin the capitulation and agreement, made between the Viceroy and Don Juan is dated San Lorenzo, 8th July, 1602: the approval of this decree by th Royal Audience of New Spain was given in Mexico City on June 20th, 1604.

It seems, on the whole, that Geronimo de Zarate Salmeron, who spen

[1] *Los Aerólitos de Chihuahua.* México, 1880.

[2] *Documentos para la Historia de México.* Tercera Serie. México, 1856, vol. 1, pp 23-26.

[3] *The Spanish Conquest of New Mexico.* By W. W. H. Davis. Doylestown, Pa 1869, p. 264.

at years in New Mexico shortly after the colonisation, is most likely to correct, and that the expedition of Oñate really left Mexico City 596. And although he doubtlessly kept up his communications with Mexico, and was followed by other companies of intended colonists, we only infer, with safety, that whenever the inscription on the Concepcion ss was made, it was desired to commemorate the fact that the mass was hat time supposed to have been already known in the year 1600.

ccording to Manuel Orozco y Berra,[1] Don Juan de Oñate and his panions in New Mexico were so eager in their search for precious als, that they neglected to construct a fort at San Gabriel, or to secure in for the colonising force. Famine set in; and the colonists, appointed in their expectations, seized the opportunity of Don Juan's ence on an exploring expedition to return to Santa Barbara in 1601. his return to San Gabriel, Don Juan declared the absentees to be ors, and condemned them to death: he set off towards Santa bara to give effect to his sentence, and reached there at the beginning January 1602.

t is clear that about the year 1600 there was an extraordinary amount raffic in the immediate neighbourhood of the masses of iron belonging the Huejuquilla group.

Another account of the landmark.

Although, in his description of Oñate's expedition, Geronimo de Zarate meron makes no reference to the iron-landmark, a search through his nal brings to light a statement, by which we are able to establish that ther a Chupaderos mass nor that of Concepcion is the one referred to the above account. After mentioning other evidence that Old Mexico i been peopled in ancient times from the North, Zarate Salmeron ceeds as follows:[2]—

"There is also an old tradition among the Indians that a lump of tallic iron, which is three leagues distant from Santa Barbola (*sic*), and f a league away from the road along which the carts pass when going to w Mexico, is a memorial of the coming of the Mexicans to people this ntry (Old Mexico); and that they halted near there, and that the idol ich used to speak with them told them that it would tarry at the place as nemorial. The iron must weigh upwards of 800 quintals, and they say

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[1] *Apuntes para la Historia de la Geografía en México.* México, 1881, p. 183.

[2] *Documentos para la Historia de México.* Tercera Serie. México, 1856, vol. pp. 47-8.

that a deity, in the form of an Indian woman, aged and wrinkled, used to draw it along. How remarkably strong the Indian old woman must have been! It is an object which all who pass along this road go and look at as a curiosity. A blacksmith of Santa Barbola (*sic*) severed a bit from one side; and others, not believing it to be an object which could have been moved and dragged from a distance, but suspecting it to be (the outcrop of) a mine of native iron, made an excavation beneath it: on the removal of the earth by which it was supported, the mass turned over on one side, and it is in that position at the present day."

This statement evidently refers to the mass mentioned in the History of Philip II. by Luis Cabrera de Cordoba. The two statements differ in character, and must have been made independently of each other, though recording the same Indian tradition: for the latter historian died in 1623,[1] and apparently was never in Mexico, while Geronimo de Zarate Salmeron's journal, preserved in Mexico City, was not ordered to be published till 1629.

To fix the position of the iron-landmark at the end of the sixteenth century we thus have two statements:—1st, that the site was on the route taken by Oñate to New Mexico, and in latitude 27½° north; 2nd, that the mass was three leagues from Santa Barbola, and half a league from the highway to New Mexico.

Santa Barbola is identical with Santa Barbara.

In the description of the journey of Espejo, published in 1586, it is stated that when the soldiers returned to El Valle de San Bartolomé, Espejo was at *the mines of Santa Barbola* (*sic*): in a later sentence the name is printed as *Barbora*. Geronimo de Zarate Salmeron spells the word as *Barbola*, but he was familiar with the above work and might have followed its spelling. Davis,[2] who had access to various old official documents, states that Espejo was at the mines of *Santa Barbara*; a place of that name is situated eight leagues south of Hidalgo del Parral.

At first it appeared that the Santa Barbola of 1582 must be quite distinct from the Santa Barbara of the present day, for according to J. A. de Escudero,[3] the mineral veins at Santa Barbara were not discovered till 1747: as shown below, the date is probably a misprint for 1547.

That the mines at Santa Barbara were worked by the Spaniards in the

[1] *Grande Encyclop.* Paris, 1889, vol. 8, p. 648.

[2] *The Spanish Conquest of New Mexico.* By W. W. H. Davis. Doylestown, Pa. 1869, p. 239.

[3] *Noticias Estadisticas del Estado de Chihuahua.* México, 1834, p. 129.

teenth century, and were antecedent to those of Parral itself, is shown the following:[1]—

'The mining place of Santa Barbara is in the Division of Hidalgo, and th-east of that town: it was discovered in the year 1547. Most of the nes have been abandoned since time immemorial, but they must have n very rich, for the veins have been worked out to their full extent." he town of Santa Barbara, in the neighbourhood of Hidalgo (del ral), was the first part of the State of Chihuahua to be peopled by the aniards. The formation of a town was begun in 1556, in consequence of discovery of the mineral veins, and in the year 1600 there were seven usand inhabitants employed in the working of the gold mines. The minution of the yield at Santa Barbara, and the new discoveries made at ral, had for result a transference of population to the latter town, and rwards further north, in consequence of the discovery of Santa Eulalia, neguilla, and later still Cusihuiriachic." The identity of Santa bara and Santa Barbola is confirmed by the following statement:[2]— or the State of New Biscay, Lionnel Waffer (*sic*) mentions some silver es, and gives Durango as the principal town: its other towns are called ros, Sta. Barbara or Barbola Endehe, and San Juan." Lionel Wafer's ages were made between 1677 and 1688: a French translation of the unt of his travels was published at Paris in 1706 under the title *Les yages de Lionnel de Waffer:* neither in the original nor in the French sion does the form Barbola appear to have been used. Endehe or lde is doubtless a separate place, and identical with the present Indé, leagues S.E. of Sta. Barbara.

The old landmark is identical with the mass now at San Gregorio.

Not one of the four large masses, which still exist in the south of the te of Chihuahua, is at present situated within three leagues of the mines Santa Barbara. The two at Chupaderos are far away from both road to New Mexico and the mines; it will be established later that the ncepcion mass was transported in 1780 from a place likewise far distant m any mining locality. The mass nearest to the place specified is that v at San Gregorio, a hacienda eight miles north-west of El Valle de San rtolomé, and situated between that town and Parral: the hacienda is a gue distant from the Parral road.

As shown below, its history, so far as known to us, is not inconsistent

[1] *Bol. Soc. Mex. de Geog. y Estad.* México, primera época, 1857, vol. 5, pp. 246, .

[2] *Algemeine Historie der Reisen zu Wasser und zu Lande.* Leipzig, bei Arkstee Merkus, 1755, vol. 13, pp. 508, 686.

with the view that the mass is the old landmark: no stress can be laid the difference between the estimated weights (800 and 250 quintals). Y the present location of the mass does not accord at all precisely with t specification given by Geronimo de Zarate Salmeron.

Santa Barbara is about ten leagues distant, in direct line, both from t hacienda of San Gregorio and from the highway (now in use and whi has been in use for centuries) to New Mexico. A cart-road, however, n goes through Cerro Gordo, Torreon, Bocas, Cuevas and Hidalgo del Parr and passes within three leagues of Santa Barbara; if this road existed the year 1600, and is the one referred to by Geronimo de Zarate Salmero the mass must have since been transported many leagues by the Spaniard On the other hand, if the road through El Valle de San Bartolomé signified, the distance of three leagues from Santa Barbara is much t small.

The large "Durango mass" mentioned by Humboldt.

After the large iron-landmark had been neglected and almost forgotte outside its immediate neighbourhood, for two centuries, public attenti was directed to the existence of such a mass by Humboldt, in his class work on New Spain: unfortunately, owing to his ignorance of the previo history of the iron and his misunderstanding of the statement as to situation in Mexico, his reference to it was of such a character that it l led to an incredible amount of controversy and vain searching of t country.

In describing the city of Durango, he says:[1]—"It is in the neighbo hood of (the city of) Durango that is seen, isolated in the plain, t enormous mass of malleable nickel-iron, which is identical in composit with the meteorite which fell near Agram, in Hungary, in 1751. D Fausto d'Elhuyar, Director of the Royal School of Mines of Mexico, ga me some fragments which I have presented to various European collectio and Vauquelin and Klaproth have published analyses of them. I assured that this Durango mass weighs nearly 19,000 kilograms, which 4,000 more than that of the mass discovered at Otumpa, in Tucum (South America), by Rubin de Celis."

Various opinions as to the "Durango mass" of Humboldt.

Chladni (1819)[2] expressed the opinion that Humboldt had been wron

[1] *Essai cit.*, Paris, 1811, vol. 1, p. 293.

[2] *Ueber Feuer-Meteore*, Wien, 1819, p. 337.

ormed, and that the big mass was identical with the comparatively small e at Charcas (578 kilograms): this opinion was based on the negative dence that Sonneschmid[1] in his Review of Mexican Mining, published in 04, had made no mention of a large mass near Durango. This line of ument is untenable, for Chladni, at least; since he himself acknowledges existence of the Sierra Blanca masses, which are themselves unnoticed Sonneschmid's work: the fact is that Sonneschmid was only describing mineral districts which he had himself visited, and he incidentally ntioned the masses of meteoric iron at Charcas and Zacatecas, because y were in the districts being described: as none of the mines in the ighbourhood of El Valle were under discussion by him, we might e expected that the masses of meteoric iron belonging to that part of xico would be unmentioned, whether their existence was known to him not.

Hardy (1829), as stated below, thought that the mass was possibly ntical with that of San Gregorio.

Ramirez (1843)[2] denied the existence of the large mass near Durango, expressed the view that the fragments given to Humboldt had been en from the Zacatecas mass.

Partsch[3] (1843) and Boguslawski[4] (1854) thought they had been brought m Toluca.

Weidner[5] (1858) also denied the existence of the large mass, and ressed the opinion that the fragments were either from the Labor de adalupe, near Durango, or from one of the large masses "at Rio Florido l Concepcion."

Humboldt, on the other hand, still declined to regard the mass as thical: he assured Burkart (1856) that D'Elhuyar had talked to him ut the mass, not once, but a hundred times![6] Burkart, thereupon, in made inquiry in Mexico, and heard (1857)[7] that a large meteorite lly existed in the plain east of the city of Durango; and he was mised further information. This never arrived, and Burkart s informed by other persons that the mass was not to be

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Mineralogische Beschreibung der vorzüglichsten Bergwerks-Reviere von Mexico oder spanien, Schleiz, 1804.

El Mus·o Mexicano ó Miscelanea Pintoresca de Amenidades Curiosas e Instructivas, xico, 1843-5, vol. 1, p. 29.

Die Meteoriten zu Wien, 1843, p. 112.

Pogg. Ann., Ergänzungsband 4, 1854, p. 411.

Bol. Soc. Mex. de Geog. y Estad. Primera época, México, 1858, vol. 6, p. 61.

Neues Jahrbuch für Mineralogie, 1856, p. 285.

Ibid., 1857, p. 53.

found :[1] being still not convinced that no such mass existed near the cit he suggested that the Breña—a volcanic group between Durango City ar Nombre de Dios—should be closely searched. Later still (1866),[2] owing the continued failure of the searches, he reluctantly inferred th Humboldt must have intended to indicate one of the Chihuahua masse and that he had only mentioned Durango because there was no other b town in the neighbourhood.

Tarayre,[3] after a visit to Durango, thus reported (1867) :—"Sever masses of meteoric iron are met with : one of them, weighing about 20 kilograms, is used as an anvil by a blacksmith of Durango. It was fou in the neighbourhood of the city. There has been much talk of the lar meteoric mass, *three-fourths buried in the plain*, not far from th hill called Mercado. Humboldt estimated the weight as 19,000 kilogram according to information furnished to him at Mexico. The mass h never been dug out so as to permit of an exact estimation of the weigh and it appears there may be some exaggeration in the above figure."

This statement, which seemed by its additional detail to confirm th existence of the mass, caused Burkart to resume his inquiries once more and, as a result, in 1871, he reported[4] that one person had been unable find it, that another hinted that he knew where it was but was keeping th place a secret, while a third expressed doubts as to its existence ; in th end Burkart died without arriving at the true solution of the problem.

The Huejuquilla masses were at one time known as "Durango iron."

And yet the explanation is an extremely simple one. At the time wh Humboldt was in Mexico, and for many years afterwards, till the rebellio against Spain, the Province of Durango or New Biscay included, not on the present State of Durango, but also those of Chihuahua and Coahuil hence the whole Huejuquilla group was then in the *Province* of Durango and before other masses had been found in the same Province, they cou very appropriately be termed "Durango iron." Humboldt merely mi understood the intended meaning of the term Durango, taking it to be th City instead of the Province.

That this is the true explanation there cannot be a shadow of a doub The structure of Humboldt's initial sentence clearly indicates that he w referring to some large mass of which the existence at the time of writin

[1] *Neues Jahrbuch für Mineralogie*, 1858, p. 773.

[2] *Ibid.*, 1866, p. 408.

[3] *Archives de la Commission Scientifique du Mexique*, 1867, vol. 3, p. 270.

[4] *Neues Jahrbuch für Mineralogie*, 1871, p. 851.

s a matter of common knowledge: though, indeed, the suggestion common knowledge may be wholly based on the publication of the alysis of his fragment by Klaproth in 1807.

But the "iron-landmark," in the Province of Durango, near latitude 27½°, d been then known for more than two centuries: since 1780 the ncepcion mass, also in the Province of Durango and situated "upon a el plain, twenty miles from any mountain," had been lying close to a line traffic, along which, at the time when Humboldt was in Mexico (1803), ousands of mules were passing every week: an account of the discovery large masses of iron at Sierra Blanca, in the same Province, had been blished in Mexico City in 1784: a notice of the finding of a mass at La ata, also in the same Province, had been similarly published in 1802. the time of Humboldt's visit, no Mexican Province was comparable h Durango for the number of its isolated iron-masses, and the fact must e been perfectly well known to the mineralogists in Mexico City. leed, Del Rio, Professor at the Royal School of Mines at Mexico, in Mineralogical Tables[1] (1804) cites the *Province of Durango* as a ality for native iron; and in the Second Part of his Mineralogy[2] (1805), der Native Iron, he mentions "the mass weighing 300 quintals which bin de Celis found on a vast plain of South America, and *those* which found in the Province of Durango under similar circumstances." He es no more precise information than the above. This text-book mboldt was familar with: indeed, his name appears on the title-page of e Second Part, for he contributed to that Part an essay on the geology the country: in his own description of New Spain,[3] too, he expressed indebtedness for mineralogical information to the works of both nneschmid and Del Rio. It is thus impossible to escape the conclusion at the large Durango mass, about which Humboldt had often conversed h D'Elhuyar, was the one which had been lying near the road to ihuahua and in the Province of Durango or New Biscay, ever since the rival of the Spaniards in Mexico.

And at the time when Humboldt's statement was published, his verbal apprehension was doubtless considered by the Mexican mineralogists be of so trivial a character that correction by them was unnecessary: we shall see later, Hardy, who was the first to note the presence of a ass at San Gregorio itself, suggested its identity with Humboldt's Durango ass. It was not till many years after Humboldt's visit that the assignation

[1] *Tablas Mineralogicas;* México, 1804, p. 57.
[2] *Elementos de Orictognosia*, Segunda Parte, México, 1805, p. 40.
[3] *Essai cit.*, vol. 1, *Introduction géographique*, p. L.

of the El Valle and Huejuquilla district to the State of Chihuahua rendered the term "Durango iron" quite inappropriate, and thus made Humboldt's statement quite inexplicable even to those living in Mexico.

[In the Index of the *Gazetas de México* for 1793, there is a reference to a notice on page 59 '*De acero de peso de 2,000 arrobas.*' A complete copy of the Gazette for that year is preserved neither in London nor Paris. The weight 2,000 arrobas (or 500 quintals) approximates to that mentioned by Humboldt.]

No stress can be laid on the discrepancy between the estimated weight of the "Durango" mass (19 tons) and the latest estimate of that of the San Gregorio mass (11 tons). Estimates of the weights of such masses depend very much on the estimator: the iron-landmark was supposed three centuries ago to weigh about 40 tons (800 quintals); the San Gregorio mass was stated by Butcher to weigh about 5 tons. The larger of the two masses at Chupaderos weighs, according to one recent estimate 15½ tons, according to another 82 tons.

The labels of those "Durango" fragments which have been given to European collections by Humboldt may thus be safely altered to indicate that the fragments belong to the Huejuquilla group: if taken from the big mass mentioned by him, they are fragments of that of San Gregorio; but if they were given to him merely as "Durango iron," they may belong to any of the masses of the Huejuquilla group known at that date.

Humboldt only referred to the more important masses previously recorded.

We may incidentally remark that the only Mexican masses of iron mentioned by Humboldt[1] are all remarkable as being either individually large (Durango, Zacatecas, Charcas), or as forming a numerous group (Toluca): that if we take Durango to indicate a "Province of Durango" mass, all of them are included in those previously mentioned by Del Rio and Sonneschmid; and that of the remainder mentioned by one or other of those two writers, but omitted by him (namely, Misteca and Guangoche) almost nothing was at that time known."

It is obvious that Humboldt's remarks were made under the impression that he was merely making mention of masses which had already attracted much notice in Mexico itself.

Supposed meteoric origin of the hill called Mercado.

Humboldt's misinterpretation of the term *Durango iron*, led to a wild

[1] *Essai cit.*, vol. 1, p. 293; vol. 2, p. 582.

sinterpretation of Humboldt's own statement; for, as no mass of teoric iron was known in Durango City to be lying on the neighbouring in, it came to be a matter of common belief that Humboldt was referring the Cerro Mercado, a hill close at hand, and was expressing the opinion t the Mercado is nothing else but an immense meteorite! In 1846 xton passed through Durango City, and the confusion at that date is strated by the following remarks :[1]—

"'Durango is celebrated for the enormous mass of malleable iron which s isolated in the plain about three miles from the town. This rock is posed to be a meteorite, as its composition and physical character are ntical with certain meteorites which fell in 1751 in some part of ngary, and analogous to the general character of others of the same ure, of which the meteoric origin is equally certain and authenticated. contains 75 per cent. of pure iron, according to the analysis of a xican chemist; and some specimens, which Humboldt procured, were lysed by the celebrated Klaproth with, I believe, the same result."

The general prevalence of this belief is sufficiently shown by the fact t in 1843 Ramirez,[2] and in 1858 Weidner,[3] published memoirs relative the Mercado, in which they deemed it necessary to disprove in an borate way the meteoritic theory of its origin, supposed to have been ught forward by Humboldt.

t need scarcely be said that Humboldt never expressed such an nion: in his work on New Spain, it is true, he mentioned the hill led Mercado and the Mexican meteoric irons almost simultaneously, but rely because he was describing the modes of occurrence of iron in xico, and the Mercado was known by the Mexican mineralogists to be enormous mass of iron-ore. In fact, Humboldt himself never travelled far north as Durango, and could only give such information about the l as had been supplied to him by others.

Hardy.

After Humboldt's reference, the next mention of the mass was made Hardy,[4] who travelled through the neighbourhood in 1827: it is the t record of the presence of the mass at San Gregorio. He says:—

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[1] *Lib. cit.*, p. 86.

[2] *El Museo Mexicano ó Miscelanea Pintoresca de Amenidades Curiosas e Instructivos*, xico, 1843-5, vol. 1, p. 28.

[3] *Bol. Soc. Mex. de Geog. y Estad.* Primera época, 1858, vol. 6, p. 59; and *Neues rb. f. Min.*, 1858, p. 769.

[4] *Travels in the Interior of Mexico in* 1825-8. By R. W. H. Hardy. London, 9, p. 481.

"From the hacienda of Santa Cruz to the Real del Parral the distance is 12 leagues. Nine leagues on the same road is the town of San Gregorio, where there is an enormous mass of malleable iron and nickel, perhaps the meteorite which Mr. Humboldt describes as being near the town of Durango. Real del Parral had formerly a population of fifty or sixty thousand souls, and was very celebrated in its day, which has now gone by. Many attempts have been made to melt down this mass of iron, but without success. An Italian imagined that by heating one side of it he should be able to cut off as much of the metal as he wanted. Accordingly he piled on the part where he intended to commence his operations an immense quantity of wood to which he set fire, and by dint of united blast of five or six forge-bellows he succeeded in giving it a red heat, which indeed was so insupportable that to his astonishment he could not come near it. However, I am told that, by applying a wall of thick boards before him, he succeeded in obtaining three pounds of iron; which three pounds cost him 130 dollars, and they were not worth four."

Hardy left the hacienda of Rio Parral (not Real del Parral) at 5 a.m., reached Santa Cruz at 8 a.m., and was in El Valle de San Bartolomé at 8 p.m. the same day: there is an element of doubt as to whether he can have had time to go to the hacienda to see the mass, for it is some distance from the road to El Valle: he gives no description of the mass or of its position, and fails to mention the inscription upon it, which, according to one account, is dated 1821.

The population of El Valle was then 28,000.

Bartlett.

Bartlett heard of the existence of the San Gregorio mass in 1852, but he did not journey to see it.[1]

Butcher and Lawrence Smith.

Dr. Butcher detached some fragments and sent them to Professor Lawrence Smith,[2] who published (1871) a sketch of the mass, and said:—"Upon one part of its surface 1821 is cut with a chisel, and above this date the following inscription in Spanish, '*Only God in his might can destroy this iron, for none on earth is able to divide it.*' It lies within the enclosure of a hacienda, having been hauled to the ranch many years ago by the Spaniards, who thought that it could be made use of as iron for farming

[1] *Lib. cit.*, vol. 2, p. 458.

[2] *Amer. Jour. Sc.*, 1871, ser. 3, vol. 2, p. 336.

msils. It is said to have fallen quite near its present site, and from its ge bulk and weight, which is calculated to be about 5 tons, it could not e been transported very far. Nothing more is known of its history." The place designated throughout as El Para by Lawrence Smith is lly Parral (or Hidalgo del Parral).

Parras.

Burkart[1] (1871) quotes an account of the mass communicated to him a letter by Don Anastasio Parras (not Porras) of El Valle de San tolomé: mention is made of the attempt to reduce the mass, and also he above inscription, but the inscribed date is given as 1828, a date sequent to that of Hardy's journey. Parras further says that the mass st have fallen 7½ leagues from the hacienda of San Gregorio; that ne knew at what time it had fallen; but that it was certainly long for since the beginning of the eighteenth century, the mass of iron, bare by the rain, had been used as a boundary-mark of the hacienda an Gregorio and the landed property of the town of El Valle. Parras es that the mass was moved to the square of the hacienda about fifty rs before the date of his letter.

s Parras says that the mass was unknown till its discovery near the ndary, there must be an error of printing in his statement of the dis- e of removal, for the hacienda is only eight miles from El Valle lf: probably 1½, not 7½, was written by him.

ven if the previous history had been actually lost, as Parras supposed, might have safely inferred that the mass could not have been lying r so important a town as El Valle for one or two centuries without g discovered, and that the mass had been known to former inhabitants he town before the occasion when it was again laid bare by the rain.

We shall see that exactly the same account of revelation by a shower of , within a short distance from the hacienda, was given for the cepcion mass, in 1871, by the actual owner, and yet it is now blished that the mass had been removed from near Huejuquilla in 0: it is remarkable, too, that there is almost exactly the same ition relative to the attempt to cut large pieces from the two masses.

Castillo.

astillo (1889)[2] says:—"It fell at the place called El Morito, 4½

[1] *Neues Jahrbuch für Mineralogie*, 1871, p. 853.

[2] *Cat. Des. cit.*, p. 7.

kilometres from the hacienda of San Gregorio, and the then proprietor (? 1600), Raphael de Pastrana, had it transported to the square of the hacienda, where it still lies."

Knotts.

In a letter sent in answer to my inquiries, Mr. J. D. Knotts of Parral states that, according to local tradition, the mass was moved, some 130 or 140 years ago, to the hacienda of San Gregorio from El Morito, about two leagues distant in an easterly direction. About four or five years since it was moved by the present owner from the centre to the corner of the hacienda, about 70 feet, to form part of the house: 50 men with levers were employed in the latter removal.

B. The Concepcion mass.

The following are the accounts which have been published at various times relative to the mass now at the hacienda of Concepcion:—

Connolly.

Henry Connolly,[1] Governor of New Mexico, with whom General Carleton had been discussing the meteoric iron of Tucson, gave him the following information:—"In the State of Chihuahua, and at the hacienda of Don Juan Nepumocena Urquida (*sic*), say 180 miles south of the city of Chihuahua, and directly on the road from that city to Mexico, and directly among the houses of the above-named hacienda, on the left hand side of the road going to the city of Mexico, and within from 30 to 50 yards of the main road, is what is supposed to be a meteorite. I saw it nearly every year for 20 years, the last time in 1846. It is a large mass of solid iron, standing like a post in the earth, from which it projects vertically about 4 feet. Its diameter at the surface of the earth is from 2 to 3 feet. It diminishes in size a little from the earth to its apex, which is irregularly rounded. The part above the ground would weigh a ton or more."

Lawrence Smith and Weidner.

Probably this is the mass which had been previously referred to by Lawrence Smith in 1854-5:[2]

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[1] *Smithsonian Report for* 1865, p. 124.

[2] *Amer. Jour. Sc.*, 1855, ser. 2, vol. 19, p. 160.

"Weidner, of the mines of Freiberg, states that near the south-western border of the Bolson de Mapimi, on the route to the mines of Parral, there is a meteorite near the road of not less than a ton in weight.

According to Manuel Orozco y Berra,[1] Weidner was at Parral, in the year 1850, as engineer to the Prieta and Tajo Mining Company, and published plans of the mines; in the same year he prepared a description of the route from Parral to Durango and Monterey (*Itinerario y carta geognóstica del camino del Parral para Durango y Monterey, formada en* 1850 *por Federico Weidner*). The statement quoted by Smith is probably taken from the latter work, a copy of which is inaccessible to me.

Simson.

Robert Simson,[2] writing about the year 1866, but quoting from memoranda made at some previous time, says :—"About halfway between El Valle and Parral, on a bend of the Rio Florido, at a place called Concepcion, is a most splendid specimen of meteoric iron. It is 4 feet above ground, and almost pure in quality. It is from two to three feet one way, by probably two to five feet the other, very regular in shape, and where worn by the rubbing of hands, &c. of passers-by is bright, and to all appearance, is nearly pure metal. The steel hatchet cuts into it easily, but with our means at hand we found it impossible to detach any part of it. It stood at the corner of the house, apparently to guard it from collisions of wagons and the like. The majordomo said this meteorite had, as he had heard, fallen from the heavens, and had been brought from a distance, from a place where other specimens also existed. Such we found to be the prevailing account of this mass among the people of the place. I would state that from La Concepcion to the Rio Grande there is an excellent road leading through Saltillo and Monterey, and save in respect to its weight, there would be no difficulty in conveying this meteorite (to the United States). The common carts of the country, with solid wooden wheels, could well convey it."

There is an error in the above statement of locality, for the hacienda of Concepcion does not lie between El Valle and Parral; indeed, El Valle itself is halfway between Parral and the hacienda of Concepcion: as discussed above, there is a large mass at San Gregorio between El Valle and Parral, but being distant from the main road it does not attract as much notice from travellers; Simson's letter is of special importance as a record

[1] *Apuntes para la historia de la Geografía en México.* México, 1881, p. 364.

[2] *Smithsonian Report for* 1867, p. 472.

of the tradition of the removal from a distant place, where other masses were still lying, and of the excellence of the roads in its neighbourhood.

Bartlett and Urquidi.

Bartlett,[1] who was travelling in 1852 by way of Huejuquilla and Rio Florido, made an excursion from his direct route to view the mass: he says:—

"We came to a small stream, where, encompassed in a grove of cotton-woods, lay the pretty village (Concepcion) to which we were destined. On our arrival we stopped under the shade of some large trees, and dismounting at once discovered the object of our search, about 50 yards distant, at the corner of a large building. This was the residence of Don Juan Urquida (*i.e.* Urquidi), the proprietor of the hacienda and large estates adjoining, and formerly Governor of the State. That no time might be lost, Dr. Webb immediately set to work with his hammer and cold chisels to cut off some pieces from the large mass of iron before us. This he found to be an undertaking of great labour, in consequence of the extreme tenacity and hardness of the mass. After an hour's work with a man to assist him, he succeeded in cutting off 3 or 4 small pieces, which did not altogether weigh an ounce, and were barely sufficient for an analysis. Five chisels having been broken, the doctor had to desist from his labours, much to our regret, as we were desirous to obtain some specimens for cabinets. While this was going on I took a couple of sketches of the mass showing opposite sides, and also took measurements; but the form was so irregular that these measurements can only aid in conveying an idea approximately of its bulk. Its greatest height is 46 inches; greatest width 37 inches; circumference in thickest part 8 feet 3 inches. Its estimated weight, according to Señor Urquida, is 3,853 lbs. While we were at work, Señor Urquida the younger, the brother of Don Juan, came out. He said it was originally found about 300 *varas* (270 yards) from its present location, and had been moved at different periods by the people of the hacienda to the place where it now stands. It was brought hither with the design of putting it in a blacksmith's shop to be used as an anvil, although it had never been so employed. An attempt was made to reduce it, by building a large fire round it and heating it to a white heat. But so intense was the heat from so large a mass that the workmen could not approach it, and all their labour was lost. The expense of this operation was more than 100

[1] *Lib. cit.*, vol. 2, p. 157.

lars, and resulted in obtaining a piece of the metal large enough work into a pair of spurs."

Urquidi.

An account of the Concepcion mass, published by Francisco de P. de quidi,[1] places on record as much as was known, in August 1871, at hacienda itself.

The following extracts relate to the history:—

"The place at which the mass is now located is not that which was first wn. By tradition we know, though in an indirect and inexact way, t at a time very remote it was at a point distant more than 1,000 *varas* m the *casa principal* of the hacienda: according to the same tradition, mass was transported to the neighbourhood of the *casa principal* and ced in front of the church door. There it was known by persons who e not yet been long dead. At the beginning of this century, a nager of the hacienda sought to profit by transporting it to a forge to used as an anvil: it was at the door of that workshop when the present ers (*i.e.* Urquidi) of the hacienda first knew it: from there they had it ed to the spot where it now is, at a corner of the *casa principal*, and it placed on a small pedestal of masonry. Many little pieces e been hacked from the mass; from some of them have been forged ious articles of smithy-work, others have been taken away as specimens. the same district there are three other masses quite similar in their terial: one 12 leagues to the north-west, at a hacienda called San egorio, and the other two at 25 or 30 leagues to the north-east, at 160 es from each other, in a part of the desert of the Bolson de Mapimi, r a place known as Chupaderos, on a hill outside the mountain-ridge. other mass of this kind is known to exist in all this extensive territory, less it be the Tucson iron, which, along with that of Descubridora, may ssibly have fallen from the same meteor."

Burkart,[2] though apparently quoting from what is virtually the same count, mentions one or two points not in the above paper: they may ve been given as marginal notes on a copy sent to him, along with a gment of the mass, by Urquidi: he says that according to report mass had been laid bare in the copse, about 800 *varas* from its present sition, in a water-course produced by a violent shower; and that the ss was still near the smithy in 1823.

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[1] *Bol. de la Soc. Mexicana de Geog. y Estad.* Segunda época, 1871, vol. 3, 275.

[2] *Neues Jahrbuch für Mineralogie*, 1871, pp. 852-3.

Castillo and Urquidi.

According to Castillo (1889),[1] F. Urquidi states on the authority of letter of his uncle, A. Urquidi, that the mass was transported to Concepcio from the Sierra de las Adargas, near Huexuquilla (*sic*) on 29th Apri 1780. Apparently Urquidi must have discovered the letter since th publication of his paper in 1871 : the latest information is thus in muc closer agreement with the statement made by the majordomo to Simso before the year 1866.

Sierra de las Adargas is not given on the available maps, but Don Jos de la L. Soto, the owner of the hacienda of Chupaderos, informs me th the name is applied to a hill (*pequeña montana*) eight or nine leagues sout of the town of Jimenez (Huejuquilla), and within that jurisdiction.

C. The Rio Florido mass.

The town of Rio Florido is at the junction of the roads which lead fro Huejuquilla and El Valle de San Bartolomé respectively to Durango Cit Hardy says:[2]—"I left El Valle at 7 a.m. and arrived at the hacienda Concepcion at eleven. This I passed, and reached the hacienda Rio Florido at 3 p.m. The house is a palace, with a long colonnad in front. It was built by Father Juan Ceréra, a Spanish priest, durin whose lifetime the hacienda was celebrated as one of the richest Mexico."

The mass said to have been at the hacienda of Rio Florido appears be really identical with that of Concepcion.

The information relative to the mass is small. Weidner[3] first referr to it incidentally in 1858 :—"I have actually seen, on the very edge of t road from Durango to Chihuahua, at the haciendas of Rio Florido a Concepcion, two masses of malleable iron which appear to be meteorites Castillo[4] (1889) says :—"In 1866, Federico Weidner, when giving r some information relative to the meteorites of the Northern Stat of Mexico, spoke to me of a mass which was at the hacienda of Rio Florid on the old highway from Mexico to Chihuahua. The mass was abo half as large as that at the hacienda of Concepcion, flatter than the latte but presenting the same characters. As Weidner assured me that he h hacked some fragments from it, I mention the mass here : I have be

[1] *Cat. Des. cit.*, p. 7.
[2] *Lib. cit.*, p. 483.
[3] *Bol. Soc. Mex. de Geog. y Estad.* Primera época, 1858, vol. 6, p. 61.
[4] *Cat. Des. cit.*, p. 9.

nable to find any other description of it, and during my visit to the acienda of Rio Florido itself, in March last (1889), I could neither find ae mass, nor get any information relative to it." In answer to inquiries om Burkart[1], made through Stahlknecht of Durango, Weidner wrote, on 0th September, 1870:—"During a journey to Chihuahua, I saw wo masses, one at the hacienda la Florida (*sic*), the other at the hacienda oncepcion. Without delaying the caravan I was able to hammer off a nall piece of the *former* meteorite, and of the external character of this ass I remember the following:—It has no predominant form, and could t most be compared with a heavy club. The thinner part is buried deep a the earth, the free, visible, broader part is about a metre high and 40 entimetres thick. Its surface is rounded and kidney-shaped; everywhere mooth, and in parts bright, like polished steel, although covered here and ere with pores. An outer rind or black crust, differing from the interior, not observable. In hardness it seemed to be equal to cast iron; its ection was fairly smooth: on its fractured parts it showed a hackly ppearance, like that of silver. From its place of preservation and its osition, one may infer that it has been hauled thither by the landlord om somewhere in the neighbourhood, and has been sunk in the earth ose to the corner of the house as a corner-stone."

In 1866, Whitney[2] remarked:—"Dr. J. B. Trask saw in August 1849 large mass of meteoric iron at the village of Rio Florida (*sic*), partly uried in the ground at the corner of the *plaza*. This may perhaps be the ame mass mentioned by Mr. Bartlett as existing at the hacienda of oncepcion, on the road from Chihuahua to Rio Florida. Dr. Trask, owever, has a distinct recollection that the mass he saw was at the illage of Rio Florida, and not at the hacienda."

Abner Woodworth,[3] in 1866, wrote to the Secretary of the Smithsonian nstitution:—"On the 7th of March, 1843, I left Paral (*sic*), a town ituated on the river Allende, State of Chihuahua, and travelling some 25 iles, course 15° east of south, passed a lump of solid malleable iron, shape r figure resembling two inverted saucers, one-third or more buried in the round, supposed to weigh 5 or 6 thousand pounds. The blacksmith at io Florido cuts off pieces with his cold chisel for horseshoes. It es upon a level plain, 20 miles from any mountain."

Comparison of the statements.

The statements made by Trask and Woodworth are useful as suggesting

[1] *Neues Jahrbuch für Mineralogie*, 1871, p. 854.
[2] *Proc. Calif. Ac. Nat. Sc.*, 1866, vol. 3, p. 241.
[3] *Smithsonian Report* for 1867, p. 472.

an interpretation which may be given to Weidner's report. Woodworth only mentions a single mass: the San Gregorio mass being a league from the road escaped his notice, but as is proved by the descriptions of Simson and Bartlett, the Concepcion mass was so conspicuous that it continually attracted the attention of passers-by and was hacked by them at discretion. Woodworth is not likely to have missed such a specimen, and have observed one of which almost nothing is known, and which is said to have been only half the size of the Concepcion mass. Simson himself refers to the stream which passes close by Concepcion as a bend of the Rio Florido: as a matter of fact, two different streams pass by the villages of Concepcion and Rio Florido, and unite about 12 miles away. Such a fact would be unknown to an ordinary traveller, whose journey along an excellent road could necessitate no reference to a detailed local map, even if such a map had then existed: the stream now called Rio Florido is the more important one, and the course of the road from the village of Rio Florido to Huejuquilla is determined by it.

There is a similar misapprehension, as regards Rio Allende, on the part of Woodworth; for Parral is not on the stream passing through Allende (El Valle), but on another stream (Rio Parral) which joins the Rio Conchos or Florido at Santa Rosalia, more than sixty miles distant from Parral.

Taking these things and the stated distance from Parral into consideration, and remembering that for many years the Concepcion mass had lain close to the smithy, it cannot be doubted that Woodworth's 'blacksmith at Rio Florido' was really the 'blacksmith at Concepcion, on a branch of the Rio Florido.' If this be granted, Trask's statement also falls to the ground: his distinct recollection that "the mass he saw was at the village of Rio Florida (*sic*) and not at the hacienda," would merely imply that the mass was outside the hacienda (of Concepcion): indeed, Bartlett's description indicates that the hacienda and village are virtually identical in location, and Connolly says that the mass was directly among the houses of the hacienda up to 1846 at least.

The statement of Weidner now becomes more capable of interpretation: his description of the position and characters of the mass at "Rio Florido" agrees so well with those given by Simson and Bartlett for the Concepcion mass, that it is impossible to come to any other conclusion than that the two masses are identical: and further, that Weidner's second and large mass was not that of Concepcion, as stated by him, but the one at San Gregorio. Of the existence of the latter, though the mass is not directly referred to, he can scarcely have been ignorant: for, as already mentioned, he was employed for some time in the neighbourhood as engineer a

rral, and his familiarity with the region is established by the fact that had constructed a geological chart of the road from the mines of Parral rough El Valle, Concepcion, Rio Florido, Cerro Gordo) to Durango and nterey.

As stated above, Lawrence Smith[1] (1854-5) says:—"Mr. Weidner, of e mines of Freiberg, states that near the south-western edge of the lson de Mapimi, on the route to the mines of Parral, there is a meteorite ar the road of not less than a ton in weight."

The search for a published authority for this statement of Lawrence ith has been fruitless; as suggested above, it may have been quoted m the *Itinerario* of 1850: the statement is of particular interest as owing that before 1854 only a single mass, apparently that of Concepcion, d been specially called attention to by Weidner.

Weidner states that he broke off the fragments at Rio Florido "without aying the caravan": his information may thus have been acquired very rriedly and be inexact, though it is still difficult to explain away his tement that *both* masses were close to the edge of the road.

If any further confirmation be required of the possibility of the confusion he two villages of Concepcion and Rio Florido, by reason of the small eam passing through the former being a tributary of the larger one ssing through the latter, it is given by the following extract from a moir by Pedro Garcia Conde relative to the State of Chihuahua 857):[2]—

"In the hacienda of Concepcion, *which is situated on the banks of the o Florido*, there is a mass of native iron got from two small hills (*sic*) in e neighbourhood, which contain so large a quantity of magnetic iron ore at they appear to be wholly composed of that mineral. The mass ferred to has a volume of about 60 cubic feet, and is composed of malleable an iron that one of the *owners of the Rio Florido*, from riosity, collected a considerable quantity of timber: setting fire to it ey succeeded in making the mass red hot; and with much trouble, for the at would not allow of anyone remaining near the mass, they severed piece, and from it the owner had some horse-trappings (*montura*) made r him. The smith who forged them said that he had never worked any her iron with such facility."

The mass referred to by Conde is clearly that which is now at the hacienda Concepcion, and is identical with the 'Rio Florido' mass mentioned

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[1] *Amer. Jour. Sc.*, 1855, ser. 2, vol. 19, p. 160.

[2] *Bol. Soc. Mex. de Geog. y Estad.* Primera época, 1857, vol. 5, p. 251.

by Simson; and the same may be said of the 'Rio Florido' mass Weidner, Trask and Woodworth.

D. The two Chupaderos masses.

According to Castillo, only two masses are known to exist in the distri east of Huejuquilla, namely those near the rancho (or hacienda) Chupaderos, 17 miles east of the town: they are only 250 metres apar

We have already proved that these masses are not, as has been supposed identical with the ancient landmark referred to in the History of Phili the Second.

The earliest reference I have been able to trace relative to th Chupaderos masses is the following made by Bartlett,[1] who passed throug the town of Huejuquilla in 1852, and sent a party to visit the masses which he had heard mention:—

"Dr. Webb procured a guide in the town who professed to know wher they were to be found: he set off from camp with our ten soldier and three others of our party, but returned next day without having foun them. It appeared that, on reaching the place designated, the guid became somewhat confused; and on being questioned more closely acknowledged that he had not been there for twenty years: he declared was not safe to go further on account of the Indians. The docto however, compelled him to lead them about for miles in every direction, b to no purpose."

Bartlett, nevertheless, expressed his belief in the existence of th masses:[2]—"From the various inquiries, made at Huejuquilla and at th hacienda of Concepcion, I learned of the existence of meteorites or mass of native iron in several places. Of those near the former place, of whic Dr. Webb went in search, there is no doubt. Some of them are ve large masses; while others are less than the one described (Concepcion)

In a paper on the meteoric irons of the Bolson de Mapimi and i neighbourhood, after mentioning the masses at San Gregorio and Co cepcion, Lawrence Smith[3] referred, in 1871, to "the locality of a hu meteorite lately discovered, of which no specimen has yet been detache and which is said to be larger than any yet found in that locality:" a in 1876 he said:—"We have some account of one even larger than S Gregorio, located in the very centre of the desert."

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[1] *Lib. cit.*, vol. 2, p. 453.

[2] *Ibid.*, p. 458.

[3] *Amer. Jour. Sc.*, 1871, ser. 3, vol. 2, p. 337: 1876, vol. 12, p. 197.

These remarks doubtless refer to the same mass, and were probably ed on vague information relative to the meteoric iron of Chupaderos.

E. The Sierra Blanca masses.

Discovery of iron masses in the Sierra Blanca, near Huejuquilla.

The following paragraph appeared in the *Gazetas de México* for Wednes-, 8th September, 1784: "In the *Sierra blanca*, three leagues from the la Nueva de Huaxuquilla (*sic*) and twelve from El Valle de San tolomé, various masses of iron weighing 20, 30 and more quintals ndredweight), have been discovered: fire has been put to them, and ne pieces have been cut off with chisels: they proved to be workable, owing to the expense the attempts have been given up."

Sierra Blanca is not given on any available map; but as the hills near ejuquilla are composed of limestone the name Sierra Blanca would not inappropriate to most hills in the neighbourhood.[1] Mr. Knotts of ral sends me the information that the name was formerly used to in-te what is now termed locally the "Sierra de la Maloya," and that sierra is eight leagues west of Huejuquilla: this must be identical h the Cerro Almoloya of the maps, which is eight leagues from Hueju-lla and five from El Valle measured in direct line; the distances do accord very satisfactorily with those mentioned in the Gazette.

A fragment of meteoric iron, labelled "Ein Stück Meteoreisen aus der rra blanca unweit Villa nueva de Haxuquilla (*sic*) in Mexico," was ntioned by Kayser in 1834 in his description of the Mineral Collection Dr. Bergemann:[2] the specimen eventually passed into the Berlin llection, and from it have been cut the small pieces now in several teorite Collections under the name *Sierra Blanca*.

It is remarkable that in the above report there is mention only of occurrence of masses in a locality of which the name is not to be found the maps, and that there is not the slightest direct reference to the still ger masses now at Concepcion, San Gregorio, and Chupaderos in same region, although two of the places are near a road which has for turies been the important highway to Chihuahua and New Mexico, and of the masses had been an important landmark at the end of the teenth century.

The report mentions the existence of "various masses, weighing 20, 30

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[1] *Memoir of a tour to Northern Mexico, &c.*, by Wislizenus, 1848.

[2] *Beschreibung der Min. Samm. des Herrn Bergemann*, Berlin, 1834, p. 465.

and more quintals," of which only the fragment acquired by Dr. Bergeman would seem to have been preserved.

F. The Tule fragment.

The information relative to the iron of Tule is very slight. Castil (1889)[1] says:—"In the Engineering School of Mexico is a small fragme of meteoric iron from Tule, Balleza, Chihuahua. There is no indicati that the fragment has been severed from one of the large Chihuahua masse or indeed from any other block."

The rancho of Tule, in Balleza, is 100 miles west of Chupaderos. the absence of any history or description, the presence of the fragment Tule within recent years is no proof that it had fallen in the neighbourhoo and still less that it had fallen with the Huejuquilla group, of whi the terrestrial age was already beyond the memory of man more than thr centuries ago.

Chemical analyses of the masses of the Huejuquilla group.

Though some analyses of fragments of masses of the Huejuquilla grou have been made, the results are far from satisfactory: the difference in t numbers for a single mass (San Gregorio) are such that it is impossible lay any stress on the variations in the analytical results for the membe of the group.

	Humboldt's Durango.		San Gregorio.			Concepcion.		Chupaderos.
	a. Klaproth, 1807.	*b.* John, 1821.	*c.* Smith, 1871.	*d.* Rammelsberg, 1870.	*e.* Lumbier, 1880.	*f.* Rammelsberg, 1870.	*g.* Lumbier, 1880.	*h.* Rammelsberg, 1870.
Iron	96·75	91·5	95·01	89·6	90·4	..	89·0	..
Nickel ..	3·25	6·5	4·22	10·4	9·4	10·23	10·9	5·12
Cobalt ..		2·0	0·51					0·82
Phosphorus ..	..	..	0·08	..	..	..	..	..

a. The fragment was sent to Klaproth by Humboldt as from t large "Durango" mass. (*Beiträge zur chem. Kennt. d. Mineralkörpe* M. H. Klaproth, 1807, vol. 4, p. 102.)

b. Of the fragment analysed by him, Professor John of Berlin says th it was part of the "Mexican mass, well-known and already investigated

[1] *Cat. Des. cit.*, p. 7.

ome chemists. It is that for which Humboldt is the authority, but I am ncertain as to whether the discovery was made by him or Sonneschmid." *Schweigger's Journal für Chemie und Physik*, 1821, vol. 32, p. 263.) The pecimen was doubtless part of the "Durango" mass, and one of those eferred to by Humboldt as given by him to various European Collections.

c. The fragment was sent to Smith by Butcher. (*Amer. Jour. Sc.*, 871, ser. 3, vol. 2, p. 336.)

d, *f*, *h*. The fragments of San Gregorio and Concepcion, and probably so that of Chupaderos (not "Chupanderes") were sent to Rammelsberg y Burkart. (*Neues Jahrb. für Mineralogie*, 1871, p. 852; *Die chem. at. d. Met.* von C. Rammelsberg, 1879, pp. 31, 32.)

e, *g*. The fragments were got from Urquidi, the owner of the Concepcion ass. (*Los Aerólitos de Chihuahua*, por Baltasar Muñoz Lumbier; México, 880, pp. 16, 17.)

III. State of Sinaloa.

The Ranchito mass.

In 1876 Professor Barcena[1] mentioned the existence in Sinaloa of an normous mass of meteoric iron more than 12 feet long, and stated that hemical analysis by himself of some fragments sent to Mexico City was progress: no detailed description, however, seems to have yet been ublished, but Barcena states that the components are essentially iron and ckel, and that the fragments are silver-white and grayish in colour.

Castillo (1889), in his list of Mexican meteorites,[2] gives the following formation:—"The mass was found in 1871 at El Ranchito, 3 miles outh-east of the mining centre Bacubirito, and measures 3·65m. long, ·0m. broad, 1·50m. high: it is irregular in shape, and is traversed ngitudinally by a fissure."

So extraordinary a mass, whether of meteoric origin or not, is worthy careful study.

Bacubirito is in a direct line with Huejuquilla and El Valle, and is 127 iles south-west of the latter town.

IV. State of Durango.

As already shown, the large "Durango" mass, to the existence of which ublic attention was directed by Humboldt, is identical with one now

[1] *Proc. Ac. Nat. Sc. Philad.*, 1876, p. 122.

[2] *Cat. Mes. cit.*, p. 5.

situated in a corner of the hacienda of San Gregorio, near Parral, in the State of Chihuahua. Several comparatively small masses of meteoric iron, however, have been found in the present State of Durango.

1. The La Plata mass.

This was mentioned in the *Gazetas de México* for 1802,[1] a year before Humboldt's arrival in Mexico: the account is as follows:—

"In the Sierra Madre, at a distance of 13 or 14 leagues from Durango City, some farm-labourers have found a mass of metallic iron weighing upwards of 11 arrobas (275 lbs.): its shape was that of two moderate-sized troughs joined together at one end: it was about three inches thick in the middle: the grain appeared to be at all parts the same: the internal concavity was wholly covered with inequalities, such as are made by the feet of a big dog in moist earth. After it had been divided with much labour into two pieces at the place of junction, one of them was worked in the forge and a ploughshare made of it. It was found to plough as satisfactorily as one made of ordinary iron. From inquiry made of Don Pedro del Pozo, at the place of the discovery, we learn that it was found about 500 yards north-east of the hill called La Plata."

The second half of the mass, like the first, has disappeared.

La Plata is not indicated on any available map, but being in the Sierra Madre must be on the western side of the city.

2. The Guadalupe and Cacaria masses.

A. The Guadalupe masses.

a. A mass mentioned by Karawinsky.

A fragment of meteoric iron was acquired in 1834 from Freiherr von Karawinsky for the Vienna Collection: he had brought it with him from Mexico, and according to his statement to Partsch[2] it had been severed from a mass which weighed several hundred pounds and lay in the plain north-east of Durango. There is no statement that Karawinsky had himself seen the original mass: nor does he mention the distance from Durango City.

The Karawinsky mass was found on the Guadalupe Estate.

We have already seen that Weidner, when discussing the Mercado

[1] Vol. 11, p. 1.

[2] *Die Meteoriten zu Wien*, 1843, p. 113.

marked in 1858 that the fragments given to Humboldt as Durango iron ight very well have been brought from Durango and at the same time ave been either got from the "Labor de Guadalupe, an estate near urango City," or from one of the two big masses which were lying at Concepcion and Rio Florido."

We infer that in 1858 it was regarded by Weidner as a recognised fact at metallic iron, not comparable in size with the Chihuahua masses, had een really found at the Labor de Guadalupe: a search for a definite atement of the discovery of metallic iron on that estate has been nsuccessful.

But I am informed by Dr. Carlos Santa Maria of Durango that the above xtensive estate begins at five leagues north-east of the city; and this is ec very direction which was assigned by Karawinsky for the locality of e mass of which he sent fragments to Vienna in 1834: hence it is tremely probable that the Karawinsky mass is the one which Weidner d in mind, when in 1858 he referred to the iron of the Labor de uadalupe. No other record of the discovery of a Durango mass on the stern side of the city before 1858 can be found.

b. A mass found at the rancho of La Pila.

A mass weighing 46·4 kilograms was turned up by a plough in 1882 at e rancho of La Pila,[1] nine leagues east of Durango. Dr. Carlos Santa aria sends me the information that the rancho is part of the estate called Labor de Guadalupe, which begins 5 leagues north-east of Durango and tends as far as La Pila, close to the hacienda of La Punta shown Garcia Cubas' map as 10 leagues south-east of Durango.

On analysis by Dr. Janke (1884), the following results were obtained:—

Iron	91·78
Nickel	8·35
Cobalt	0·01
Phosphorus...	traces
Carbon	traces
	100·14

The specimen is now in the British Museum Collection.

Confirmation of the above suggestion as to the site of the Karawinsky ass is found in the statement of Brezina, that the etching figures of the ass are identical with those of the one ploughed up at La Pila.

[1] *Abhandl. Natur. Ver. zu Bremen*, 1884, vol. 8, p. 513.

B. The Cacaria mass.

(*a.*) According to Castillo[1] (1889) this is a nearly round mass weighing 41·4 kilograms. It had been in use as an anvil by a blacksmith of Durango, according to whom it had been brought from the "plains of the hacienda of Cacaria." The hacienda of Cacaria is on the highway from Durango to Chihuahua, and is about 10 leagues, as the crow flies, north of the former city. The mass was presented by the late Gerando Ruiz to the Mexico Museum and is now preserved there.

Dr. Carlos Santa Maria tells me that the mass was in use at the forge for several years, and was sent to Mexico before 1870.

(*b.*) Tarayre[2] (1867) mentioned a block of iron, weighing about 200 kilograms, in use as an anvil by a smith in Durango City, and said to have been found in the neighbourhood. Tarayre does not state that he himself saw the mass: his statement, like that made by him at the same time relative to the (non-existent) mass "three-fourths buried in the plain," may be based on hearsay, and the estimate of the weight be very inaccurate.

No one claims to have seen two masses in use as anvils at Durango.

The distance, measured in a direct line, from the hacienda of Cacaria to the above-mentioned La Punta is 14 Mexican leagues (36 miles). But the actual dispersion of the Cacaria and Guadalupe masses may have been much less, for the plains are on the eastern or Guadalupe side of the hacienda of Cacaria, and the Guadalupe masses have been found on the Cacaria side of La Punta.

Though the Cacaria and Guadalupe masses have not yet been compared as regards their etching figures, there is every probability that they belong to a single and not very widespread fall.

3. The Mezquital mass.

A mass weighing about 7 kilograms was brought from Mexico, shortly before 1868; it was said to have come from San Francisco del Mezquital.[3] One of the districts into which the State of Durango is divided is called Mezquital: but the name San Francisco del Mezquital is not to be found on recent Mexican maps, and as San Juan del Mezquital and San Miguel de Mezquital are shown in Cubas' map as situated in the adjoining State of Zacatecas, it began to be doubtful as to whether San Francisco del

[1] *Cat. Des. cit.*, p. 5.

[2] *Archives de la Commission Scientifique du Mexique*, 1867, Paris, vol. 3, p. 270.

[3] *Comptes Rendus*, 1868, vol. 66, p. 573.

ezquital was in Durango at all. In an older map,[1] however, it appears the name of the capital of the district of Mezquital, and is thus the wn now called Mezquital: Dr. Carlos Santa Maria informs me that the ngated name San Francisco del Mezquital was used in the writings of the ssionaries.

On analysis by Damour (1868) the following results were obtained:—

Iron	93·38
Nickel	5·89
Cobalt	0·39
Phosphorus...	0·23
	99·89

The main portion (7,513 grams) of the specimen was acquired for the itish Museum Collection.

4. The Bella Roca mass.

A mass weighing 33 kilograms was found on La Bella Roca,[2] a peak of Sierra de San Francisco, near to Santiago Papasquiaro: that town is miles, in direct line, north-west of Durango City. The existence of mass became known to Professor Ward in 1888, but he could obtain no rmation as to the date of the original discovery or the name of the coverer.

On analysis by Whitfield (1889) the following results were obtained:—

Iron	91·48
Nickel	7·92
Cobalt	0·22
Phosphorus	0·21
Sulphur	0·21
Carbon	0·06
	100·10

The specimen has been cut into slices and distributed.

Masses from Durango belong to different types.

The Mezquital mass, on etching, is seen to differ completely from those Pila and Bella Roca. Specimens of the three masses now in the

[1] *Bol. Soc. Mex. de Geog. y Estad.* Primera época, 1858, vol. 6, p. 374.

[2] *Amer. Jour. Sc.*, 1889, ser. 3, vol. 37, p. 439.

British Museum were etched simultaneously: the octahedral structure of the Pila mass is so well defined that it could be traced on the polished face even before the etching; immediately after the application of the bromine-water, Widmanstätten figures manifested themselves on the faces of both Pila and Bella Roca, whereas no distinct figures could be seen on Mezquital even after prolonged action. After being washed and dried, however, the Mezquital face, though almost wholly dull, was seen to be still lustrous along straight parallel lines running completely across the face (130 mm. by 70 mm.) at intervals of one or two millimeters from each other: in fact, the etched face approximates in character to that of a Coahuila mass. This result is not inconsistent with the description of a face of small area by Daubrée, but is in complete disaccord with that of the etched face of a small fragment (149 grams) at Vienna.[1] Though meteoritic masses often vary in different parts, it seems more likely in this case that the Vienna specimen, which was acquired in 1872, had a wrong locality assigned to it, for with the exception of a fragment (170 grams) removed by Daubrée for the Paris Collection, the whole of the Mezquital mass is understood to have passed into the possession of the British Museum (7,513 grams) in 1870; and no fragment of this meteorite has ever been exchanged to Vienna.

Bella Roca is completely different in aspect from Pila, both in its enclosures and in the character of the Widmanstätten figures.

V. State of San Luis Potosi.

Meteoric iron has been brought from only two parts of the State of San Luis Potosi, namely Catorce and Charcas: as shown below, it is not at all impossible that the Charcas mass was transported to that town from the neighbourhood of Catorce.

1. The Catorce masses.

Three specimens are known to have been found quite near to Catorce and it may be assumed that they are products of a single meteor: they are:—(a) *the Descubridora mass, which is identical with the "Venagas" mass of Lawrence Smith*, (b) *a small mass seen by Burkart before* 1834, *but which has since disappeared*, (c) *a mass found in* 1885. Further (d) *Real del Guanqoche*, and (e) *Hacienda of Agua Blanca*, have been mentioned as localities for metallic iron.

[1] *Die Meteoriten-Sammlung in Wien* (Brezina), 1885, p. 60.

(a) *The Descubridora mass.*

This mass, weighing 576 kilograms, now in the National Museum Mexico, is stated to have been found between 1780-3.[1] Until 1773, nen silver (the Descubridora vein) was accidentally discovered at e summit of the mountain-ridge close to the present town of Catorce, the strict was quite uninhabited except by unsubdued Indians: within three ars there was a population of 5,000, and by the year 1826 the pulation of the district amounted to 26,000.[2] To the east of the erra de Catorce the descent to the coast commences almost immediately, nile to the west there is no ridge intervening between Catorce and catecas. In 1773 the Sierra was covered with forests, but before 50 ars had passed away not a tree or a blade of grass was to be seen. It is seems likely that the large mass was found at the time when the care- l examination of the mountain close to the present town of Catorce was de. After discovery, the mass was first moved to the hacienda of blazon, and was still there when Burkart was at Catorce in 1830, ough he was unable to go to see it: it was next taken to the amalgama- n works at San Miguel, near Catorce, to be used as a base for the ore- shing stamps: it was then removed to the hacienda of Tanque Dolores, and afterwards taken back to San Miguel; finally, it was rchased by Irizar, and presented by him in 1871 to the Society Geography and Statistics of Mexico.

The mass of "Venagas" is identical with that of Descubridora.

In 1855 Lawrence Smith[3] wrote as follows:—

"Lieutenant Gouch (*sic*) also states that the intelligent but almost known Dr. Berlandier writes in his Journal of the Commission of Limits at at the hacienda of Venagas (*sic*) there was (1827) a piece of iron that ould make a cylinder one yard in length with a diameter of 10 inches. was said to have been brought from the mountains near the hacienda. presented no crystalline structure and was quite ductile."

Smith refers in his later papers to the same statement without any ariation of the details. Burkart[4] tried repeatedly and unsuccessfully to btain information as to the locality of the hacienda; he remained under ae impression that it was somewhere between the cities of Durango and

[1] *Bol. Soc. Mex. de Geog. y Estad.*, México. Segunda Época, 1872, vol. 4, p. 319. *Naturaleza*, México, 1871-3, vol. 2, p. 290. *Cat. Des. cit.* (Castillo), p. 4.

[2] *Lib. cit.* (H. G. Ward), vol. 1, pp. 457, 471; vol. 2, pp. 232, 249, 259.

[3] *Amer. Jour. Sc.*, 1855, ser. 2, vol. 19, p. 160; 1869, ser. 2, vol. 47, p. 383.

[4] *Neues Jahrbuch für Min.*, 1858, p. 770; 1870, p. 691.

Chihuahua. Brezina thought the mass might be one of the Coahuila group, and further suggests a theory which rests upon the assumption that the mass was actually cylindrical.[1]

In the first place "Gouch" is a mistake for "Couch," as already indicated. In the next place, Couch acquired for the Smithsonian Institution[2] all the voluminous manuscripts of Dr. Berlandier, who had died in 1851: hence it seemed possible that Couch might have obtained the above information from a hitherto unpublished record.

After a tedious search Berlandier's statement was at length traced: it was found on page 50 of the "*Diario de viage de la Comision de Limites —Lo Escribieron*—L. Berlandier y R. Chovel: 1850. 4to," and literally translated, runs as follows:—

"December 22, 1827. From the mining centre of Catorce to the hacienda of Vanegas (*sic*).

"On December the 22nd we set out from Catorce to rejoin the companions whom we were expecting to meet at Vanegas, six leagues distant in a north-east direction.

"Near the hacienda of Poblacion (*sic*) is a mass of iron from which could be made a cylinder a yard in height and ten inches in diameter. No part of its surface shows any sign of crystallisation: its edges are well rounded and the iron is very ductile. We had great difficulty in severing some fragments: before ourselves, two Englishmen, provided with good tools and manual assistance, had spent a whole day in cutting off some pieces which were really not very large. We were told that the mass had been brought a distance of some leagues, but we did not hear from what point nor the mode of occurrence. The people on the estate believe that the mass is insensibly moving in a direction from north to south. We vainly used our little logic in opposition to this belief."

It is obvious that this is the authority cited by Couch, and that there has been a confusion between the hacienda of Poblazon (Poblacion), where the mass was lying, and the hacienda of Vanegas (not Venagas) to which Berlandier's party was travelling on that day.

On analysis by Murphy (1872)[3] the following results were obtained:—

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[1] *Sitzungsber. Ak. Wien*, 1881, vol. 83, div. 1, p. 473.

[2] *Smithsonian Report* for 1854, pp. 15, 396.

[3] *La Naturaleza*, México, 1871-3, vol. 2, p. 290.

Iron	89·51
Nickel	8·05
Cobalt	1·94
Sulphur	0·45
Chromium	trace
Phosphorus	trace
	99·95

(b.) *A small mass seen by Burkart before 1834.*

When at Catorce in 1830 Burkart heard of the mass then at Poblazon,[1] could get no information about other masses: somewhat later, when at Zacatecas, he saw a roundish mass, apparently complete and not a fragment, in the possession of an Italian named Chialiva: it must have weighed 10 or 12 lbs. and was said to have been got at Catorce.[2] The mass has not been heard of since: Burkart lived at Zacatecas from 1828 to 1834.

(c.) *A mass found in 1885.*

A mass weighing 92 lbs. was found by a miner near Catorce in 1885,[3] and is now in the collection of Mr. Kunz. It must have been met with before and thrown away, for on one side an opening 3½ inches long had been made, and a piece of a copper chisel had been left wedged in it: long exposure was indicated by the partial oxidation of the copper. The copper was hardened by the ancient Mexicans by the addition of a small proportion of tin: recent analysis of one specimen proved the presence of 2·13 per cent. of the latter metal.[4]

An analysis of the iron by Mackintosh (1887) the following results were obtained:—

Iron	90·09
Nickel and Cobalt	9·07
Phosphorus	0·24
Schreibersite	0·60
	100·00

[1] *Neues Jahr. für Min.*, 1856, p. 286; 1857, p. 54.

[2] *Ibid.*, 1856, p. 286.

[3] *Amer. Jour. Sc.*, 1887, ser. 3, vol. 33, p. 233.

[4] *Anales del Museo Nacional de México*, 1877, vol. 1, p. 117.

The above are the only masses from Catorce of which there is definit information; but the occurrence of iron at two other places in th immediate neighbourhood, namely, Real del Guangoche and Agua Blanc was mentioned at the beginning of the century.

(d.) *Real del Guangoche, near Catorce.*

Del Rio[1] merely specifies "Real del Guangoche, close to Catorce" as locality for native iron: he does not describe the specimens or the mode occurrence: he mentions no other locality near Catorce, nor does he recor even the existence of the mass at Charcas. No further mention of the Re del Guangoche has yet been traced, and we are thus ignorant of its precis locality: probably the statement really refers to the discovery of th Descubridora and Charcas masses; for it would be unlikely that news the discovery of small specimens, now lost, should have been sent to De Rio, and that information about the large masses, found many years befor that date and still preserved, should have failed to reach him in Mexic City.

(e.) *Agua Blanca, near Catorce.*

Del Rio gives the following both in his Tablas Mineralogicas (p. 57) an in his Elementos de Orictognosia:[2]—

"Coeto and Cotero assert that iron occurs in bands (*cintas*), one or tw inches thick, in conglomerate above the hacienda of Agua blanca (*sic*) nea Catorce. I hope some other pupil will send a piece to the college, an thus confirm the existence of terrestrial metallic iron, as announce by Lehmann for the locality of Eibenstock in Saxony. The facts as ye established, however, seem rather to confirm the (meteoric) theory Chladni."

Del Rio clearly considered the supposed mode of occurrence to requir verification: nothing has since been heard of it and the exact position Agua Blanca seems to be now unknown.

It may be remarked that it has since been established that th Eibenstock (or Steinbach) specimen, referred to above, is itself of meteori origin.

2. The Charcas mass.

Sonneschmid, who according to his preface had spent 12 years i Mexico, states in his work, published in 1804:[3]—

[1] *Tablas Mineralogicas*, México, 1804, p. 57.
[2] Segunda Parte, 1805, p. 40.
[3] *Lib. cit.*, p. 288.

At the corner of the churchyard (*church*, according to Burkart) Charcas, there stands a half-buried block of native iron: the part above surface is about 2½ feet long and 1 foot thick. It is said that the mass brought from the neighbourhood of San José del Sitio, an estate 12 ues distant, and that in the same neighbourhood several other masses e been seen firmly embedded in a limestone-like rock."

o one has yet been able to determine the position of this estate: the ae itself is an odd one; the extent of a Mexican estate was at that time erally expressed in Sitios, a Sitio being a square-league, and San José Sitio thus differs from most of the Mexican names in being without obvious meaning. In the time of Ward (1825-7) most of the hacien- of San Luis Potosi were vast sheep-walks.[1] If the estate lay in a ction north of Charcas, it would be near to Catorce, for the distance ween the two towns is only 17 Mexican leagues.

urkart[2] says (1857):—"I am informed relative to the occurrence of eoric iron in the vicinity of Catorce and San Luis Potosi that it appears if great quantities occur there on the limestone at the summit of range, partly in big masses like those of Descubridora and Charcas, ly in masses of the size of the fist and smaller.

n approximate analysis by Meunier[3] (1869) gave the following lts:—

Iron	93·01
Nickel and Cobalt	4·32
Residue	0·70
	98·03

he Charcas mass was taken possession of by the French in 1866, and w preserved in the Paris Collection: according to the Paris List, the ght is 780 kilograms.

ssible identity of original locality of the Catorce and Charcas masses.

he Descubridora mass found in 1780-3, the one found in the same dis- t in 1885, and that of Charcas, all show excellent Widmanstätten res when etched: and though there are minor differences of character, y are only such as we might expect to meet with in small etched faces different parts of even a single large mass. The figures, so far as it yet been practicable to determine them, while insufficient to establish

[1] *Lib. cit.*, vol. 2, p. 228.
[2] *Neues Jahrb. für Min.*, 1857, p. 54.
[3] *Géologie Comparée; Étude sur les Météorites;* par S. Meunier, Paris, 1867, p. 40.

either the simultaneity or the multiplicity of the falls to which the above masses belong, are not at all inconsistent with the view that the masses form a single group.

But when we remember that the removal and the original locality of the Charcas mass were still unforgotten at the time of the visit of Sonneschmid (1792-1804), and that the history of meteoritic masses passes into speedy oblivion whenever there is delay in publishing the record, we may fairly infer that the Charcas mass was found about the same time as that of Descubridora (1780-3); and probably in the vicinity of Catorce, since a careful search for silver-veins was made in the whole district after the discovery of the riches adjacent to Catorce itself: Sonneschmid says that the Charcas mass had been got from a place where several other masses had been seen, and Del Rio only specifies the neighbourhood of Catorce for San Luis Potosi iron: at the time of Ward's visit (1825-7) there was a good carriage-road from Charcas to Catorce,[1] and the transport of the large mass from the Catorce district to the church at Charcas would present no practical difficulty. Although Sonneschmid visited and described the mines of Catorce, the discovery of the Descubridora or other masses of iron in the immediate neighbourhood is unmentioned by him, unless the estate referred to as San José del Sitio was really in that region.

Taking everything into consideration, it is not improbable that all the masses yet found in the State of San Luis Potosi belong to a single fall, and have been met with in a district of no extraordinary area.

Specimen in the Poinsett Collection.

The specimen taken to the United States by Poinsett[2] and supposed by Smith to be possibly from Charcas, is probably a Toluca specimen, as shown below.

VI. State of Zacatecas.

Only one mass has been found in this State.

The Zacatecas mass.

The first known mention of the Zacatecas mass was made in the Gazeta de México for 3rd April, 1792, p. 59 :—

[1] *Lib. cit.*, vol. 2, p. 232.

[2] *Amer. Jour. Sc.* 1868, ser. 2, vol. 45, p. 77.

'From time immemorial there has been in the old St. Domingo Street
the city of Zacatecas a stone half-buried in the ground, which has been
ded Iron-stone by reason of its solidity. As to its origin there is only
oral tradition that it was found by one of the first colonists when
rking the Quebradilla mine, and has been lying near the door of his
use ever since: it was noticed there by Sonneschmid, and recognised by
n as native iron and recommended to the attention of the Government.
m Fermin Apecechea had it taken to his house and weighed: the weight
s found to be 2,000 lbs. The mass is somewhat more than 1½ yards
g, not so much in breadth, and somewhat over a quarter of a yard in
kness."

On page 155 of the same volume of the Gazette is published a letter
Sonneschmid, dated 24th July, 1792, which relates to the mass.

According to Burkart, the Quebradilla mine on the western outskirts of
city was worked immediately after the conquest of Mexico by
Spaniards.[1]

In 1804 Sonneschmid described the iron, but gave no history, simply
ing that "no probable guess can be given relative to the origin of this
narkable specimen." Burkart lived at Zacatecas in the years
8-34:[2] the mass was then in a private house, the residence of
m Angel de Abille in Tacuba Street. Burkart quotes at length the above
ement from the Gazetas de México of 1792, but adds that at the time
his own residence at Zacatecas, there was one tradition that the mass
been brought "from the north," and another "that the mass was at
atecas when the Spaniards reached there."

Castillo (1889)[3] says that the specimen was "formerly in a street of the
of Zacatecas, and was afterwards removed to the hacienda of
neguillas, which belongs to the Gordoa family. It has the shape of a
rallelepiped, and is 1·06 m. long, 0·50 m. broad, and 0·25 m. thick."

The mass mentioned by Cavaroz.

Writing from Durango on 21st September, 1864, Dr. Cavaroz
s:[4]—

'We may note the existence of large fossils at a certain place called
s Zapotes, four leagues from Cuquio. At a very fine hacienda, at which

[1] *Reisen in Mexico* (J. Burkart), Stuttgart, 1836, vol. 2. p. 58.
[2] *Neues Jahrb. für Min.*, 1856, p. 289.
[3] *Cat. Des. cit.*, p. 4.
[4] *Comptes Rendus*, 1864, vol. 59, p. 1099.

we made a general halt before reaching Zacatecas, there is a mass of iro which was found long ago in that city. A piece has been separated wit great difficulty to be taken to England for study. The mass whic remains may be 70 cm. long, 30 cm. broad, and 25 cm. thick, and has a irregular rectangular shape."

The specimen thus referred to is doubtless identical with the ol Zacatecas mass; and the piece said to have been taken to England fo study is probably the very one, weighing about twenty pounds, which ha been analysed and described in London by Dr. Hugo Müller in 1859 The Gordoa family have long owned fine estates near Zacatecas: accord ing to Ward (1826),[1] they then had purchased the fine estate of Mal Pas near Zacatecas for 700,000 dollars, and had besides a fortune of a millio dollars, acquired from the La Luz mine at Catorce which began to yiel returns in 1806; there is a hacienda bearing the name Cieneguill between Cuquio and Zacatecas.

On analysis the following results have been obtained by Dr. C Bergemann[2] and Dr. Hugo Müller[3] respectively:—

	Bergemann.		Müller, 1859.		
	1849. I.	1857. II.	I.	II.	III.
Iron	85·09	85·42	89·84	91·30	90·91
Nickel	8·00[4]	9·73	5·96	5·82	5·65
Cobalt	0·67	0·44	0·62	0·41	0·42
Phosphorus ..	..	..	..	0·25	0·23
Sulphur	0·84	..	0·13	..	0·07
Silica	..	..	..	..	0·50
Copper	0·03	..	trace	trace	trace
Magnesium	0·34	..	trace	trace	trace
Residue	3·65	1·05	3·08	2·19	2·72
	98·62	96·64	99·63	99·97	100·50

VII. States of Mexico and Morelos.

The Toluca group.

Masses of iron have been brought from various localities in the States o Mexico and Morelos: it seems likely that everyone of them was originall found in the immediate neighbourhood of Xiquipilco, a small town fou leagues due east of Ixtlahuaca, in the State of Mexico.

[1] *Lib. cit.*, vol. 1, p. 471.
[2] *Pogg. Ann.*, 1849, vol. 78, p. 406; 1857, vol. 100, p. 256.
[3] *Quart. Journ. Chem. Soc.*, 1859, vol. 11, p. 236.
[4] *Pogg. Ann.*, 1849, vol. 78: p. 410, says 7·999; table on p. 412, says 9·895; the sum of the given percentages is not 99·348 as there stated, but 100·348.

So much has been written relative to this iron that it will be convenient collect together the few original statements which relate to the actual covery of the masses (Plate II.).

1784.) "Æ" says:[1]—In the town of Xiquipilco, belonging to the trict of Ixtlahuaca, native metallic iron is met with so pure that, without other preparation than heating, it may be worked into any shape; as I e verified in two journeys, undertaken with the object of discovering if re were veins of this mineral, which would be of infinite utility: but my ervations only verified that masses of various shapes and sizes found scattered through the fields, and that the Indians keep a look for them, though the iron is at first covered with a crust of ochre. e Indians of the town and the owners of the haciendas use no other for fabrication of the necessary agricultural implements."

1804.) Del Rio[2] gives the following as Mexican localities for native :—"Zacatecas, Real del Guangoche near Catorce, Province of ango, *near Cuernavaca in Xiquipilco*, and in the Misteca."

1811.) Humboldt,[3] who had been in Mexico in 1803-4, says:—"It is onneschmid that we are indebted for a knowledge of the meteoric iron h is found at several places in Mexico—for example, at Zacatecas, cas, Durango, and if I am not mistaken, in the vicinity of the small n of Toluca."

1826.) Wilhelm Stein,[4] in a letter of 23rd April, 1825, published Nöggerath, says:—"I send a piece of native iron from Xiquipilco. occurrence of this iron deserves a closer investigation; so far tically nothing is known; and on my first journey to Xiquipilco I did succeed in clearing the uncertainty away, for notwithstanding my careful ches I was not fortunate enough to find a piece *in situ*. It is known that a considerable quantity has been found in the neighbour- during ploughing, and that it has been used for the manufacture of inds of implements."

1831.) Alzate Ramirez[5] reported as follows:—

From time immemorial, no iron has found its way to the town of ipilco and to the neighbouring haciendas for the necessary purposes. Indians of Xiquipilco collect what they can, for it is not abundant: the ers of the haciendas of Indege and Santa Isabel barter for it with the

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[1] *Gazetas de México*, Wednesday, 15th Dec., 1784, No. 25, p. 201.
[2] *Tablas Mineralogicas*, México, 1804, p. 57.
[3] *Essai cit.*, vol. 2, p. 582.
[4] *Schweigger's Journal für Chemie und Physik*, 1826, vol. 47, p. 74.
[5] *Gacetas de Literatura de México, por D. Jose Alzate Ramirez*, Puebla, 1831, vol. 381.

Indians who chance to find it, generally at the beginning of the rains, when it becomes visible among the soil. The Indians of Xiquipilco make spades and axes of the iron, and the owners of the said haciendas use it for ploughs. About the year 1776, I went to Xiquipilco to see with my own eyes the famed native iron. I found two smiths established in the town who worked the native iron : in my sight they forged it and worked it into the shape demanded of them.

(1855.) Dr. Krantz[1] stated at Bonn on 8th March, 1855 :—"I received from Mexico last autumn four masses of meteoric iron which had come from the following places, said by him to be in the Valley of Toluca :—a 43 lb. mass from Tejupilco, masses of 26 and 6 lbs. from Ocatitlan, and a 19 lbs. mass from Ixtlahuaca."

(1856.) Gustav A. Stein,[2] brother of the above mentioned Wilhelm Stein, reported as follows :—

" Having heard that the iron was found at various places in the Valley of Toluca, I went myself in July 1854 to get definite information at the small town of Ixtlahuaca : thence I was directed to the hacienda Mañi, a league north of the Indian village of Xiquipilco. In the barn of the hacienda there was a mass of iron weighing 220 lbs. : its owner told me that it had been found about 15 years before, half a league south of Xiquipilco, among the rounded pebbles of a small brook, which even in rainy weather contains little water : close by, though not in the brook itself, was found a 5½ lb. mass. A third of a league east of this locality a mass weighing some 300 lbs. had been found about twenty years before my visit. Another mass, weighing 19½ lbs., had been found a quarter of a league north-east of Mañi : one also was found three-eighths of a league east of Mañi. I was told that in times now remote large masses had been found as far away as the hacienda Mayorazgo. Some old landowners, in the neighbourhood of Ixtlahuaca, told me that knowledge of these masses of iron had been got long ago from a smith who had worked them into ploughshares and axes without using steel. The Indians of the neighbourhood for the sake of a small reward used to search for the pieces, which were then forged in his smithy. The masses, whether large or small, are now become scarce. But in the course of years a large quantity must have been worked up or taken away. The were carried as merchandise to various places, whence it happens doubt

[1] *Sitzungsb. d. niederrhein. Gesell. f. Natur- und Heilkunde zu Bonn*, 185 p. xlvii.

[2] *Sitzungsb. d. k. Ak. der Wissensch., Mathem.-Naturw. Classe*, 1856, Wien, vol. 2 p. 218.

ss that masses of meteoric iron, though in each case originally got Xiquipilco, have been known also under the names—Ixtlahuaca, ppetitlan, Mayorazgo, Gavia and Toluca. A meteoric iron has lately been escribed as from 'Tejupilco in the Valley of Toluca.' I have no doubt at Tejupilco is a mistake for Xiquipilco. The town of Tejupilco is not in ne Valley of Toluca; the town is well known to me, for it is only 9 leagues est of Arcos where I lived; and I have never heard of any find of iron in s neighbourhood. The specimens described by Dr. Krantz are certainly om Xiquipilco."

(1856.) Burkart[1] reported:—"I was told, when I dwelt in the eighbourhood, about 30 years ago, that the locality was Toluca, but could get no meteoric iron there: I did not learn till later, when I was ving at Zacatecas (1828-34), that the iron was really found at Xiquipilco, ut in spite of all my efforts, I was not able to get a specimen of . * * * I think Tejupilco is a mistake for Xiquipilco. I cannot nture to decide whether the specimens said to have been got from tlahuaca and Ocatitlan were actually found there or were only purchased ere: I am inclined to think the latter must have been the case."

(1857.) Krantz[2] reported that a special search had been made in the alley of Toluca in 1856 at his request: no fewer than 69 masses were und and sent to him, but the heaviest only weighed 1¾ kilos., and the tal weight was only 49½ kilos.

(1858.) Von Babo[3] analysed a fragment of a specimen which weighed 37 grammes: according to Schleiden of Trojes in Mexico "it came om the neighbourhood of Sizipilec, in the Valley of Toluca, where similar ieces are found distributed over a considerable area, and are frequently rned up by the Indians when ploughing."

(1889.) Castillo,[4] in giving a list of the specimens preserved in the exico Collection, states as follows:—

"1. Meteorites of a single fall found at *San Juan de Xiquipilco*, in the alley of Toluca, State of Mexico.

(a) Meteoric iron of *Ocotlan;* small fragment.

(b) Meteoric iron of *Tenango;* small fragment.

(c) Meteoric iron of the *Cerro de Santiago*, near the hacienda of Gavia; nall fragment.

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[1] *Neues Jahrbuch für Mineralogie*, 1856, p. 299.

[2] *Pogg. Ann.*, 1857, vol. 101, p. 152.

[3] *Ber. über die Verhandl. d. naturf. Gesellschaft zu Freiburg i. B.*, 1858, vol. 1, p. 56.

[4] *Cat. Des. cit.*, p. 3.

(d) Meteoric iron of the *Sierra de Monte-Alto*, District of Xiquipilco; small fragment.

(e) Meteoric iron of the hacienda of *Mañi*, District of Ixtlahuaca; small fragment.

It is in the neighbourhood of Xiquipilco that the largest number of fragments of every dimension have been found: some reach a weight greater than 45 kilos. The inhabitants discover these fragments either in the fields when ploughing, or in the ravines hollowed by the passage of the water after heavy rains.

2. Meteorite of *Ameca-Ameca*, State of Mexico. It is a small nodule of meteoric iron found in the town of Ameca-Ameca. It is in the National Museum of Mexico.

3. Meteorite of *Los Amates*, State of Morelos. It is a nodule of iron which was found among several specimens of iron-minerals brought from the rancho of Los Amates, on the road from Mexico to Iguala and in the neighbourhood of the latter place.

4. Meteorite of *Cuernavaca*, State of Morelos. It is a fragment of meteoric iron found, so it is said, on the road from Mexico to Cuernavaca, in the mountains. It is in the National Museum of Mexico."

We may remark, with Chladni, that the shower of iron must have fallen before, probably long before, the arrival of the Spaniards, or there would have been some surviving tradition of the occurrence, for the Valley of Toluca has been inhabited from time immemorial: the meteor of 1521, already referred to, is not known to have yielded any tangible material. Hence the time during which the masses have been known as desirable objects for smithy-work is also probably very long: the forging of them into agricultural implements was already in full swing about 1776: they were then regarded as a terrestrial product. Stein distinctly states that they were articles of merchandise, and were taken for sale to various towns in the neighbourhood. And it is worthy of mention, that in the only cases in which names of places not immediately near to Xiquipilco are attached, the early history of the specimens cannot be traced. Further, those who have inquired into the occurrence in the neighbourhood itself could only hear of discoveries having been made within a few miles of Xiquipilco; in fact, for the first 50 years after the visit of Alzate Ramirez scarcely any other name is mentioned. Stein was in the neighbourhood of Toluca at the time when the specimens said to have been got from Ocatitlan, Tejupilco and Ixtlahuaca, were sent to Krantz in Germany, and asserts that the original locality was certainly Xiquipilco.

Del Rio (1804), who was living in Mexico City, it is true, cites a Mexican ocality "near to Cuernavaca in Xiquipilco," but such a statement, as it ands, is unintelligible. Cuernavaca is farther from Xiquipilco than from e capital where Del Rio was located: as the crow flies, Cuernavaca is 52 iles from Xiquipilco, while each of those places is only 35 miles distant m Mexico City. It is almost certain that Cuernavaca, which has long en a well-known place, is given by Del Rio in error for Ixtlahuaca; d that it was intended to aid in specifying the approximate locality of e small Indian hamlet of Xiquipilco: in 1805[1] Del Rio incidentally ferred to the masses of Xiquipilco without mentioning either Cuernavaca Ixtlahuaca.

On the other hand, it is possible that a comma has been omitted during inting, and that the sentence as written by Del Rio was "*junto á atorce, en Xiquipilco*," thus indicating two distinct localities: Cuervaca, however, was not again mentioned as a locality for metallic iron 1889.

As regards the meteorites of Cuernavaca, Ameca-Ameca, and Los mates, mentioned by Castillo in 1889, there is, in the first place, no idence that they have been examined and found to be identical in aracter with those from Xiquipilco. In the second place, even if the entity of character is ever proved, there will remain the possibility that e fragments have been transported from the Valley of Toluca.

The valley from Cuautla to Cuernavaca is a very fruitful one, and at the me of Ward's visit (1825-6) was one succession of beautiful haciendas: robably many of the Xiquipilco fragments were carried over the ountains to be sold at the haciendas, either as curiosities or as material r the manufacture of agricultural implements.

The Ameca-Ameca meteorite "is said to have been found in that small wn." Ameca-Ameca is a town where there are now iron-foundries, and here "ploughs, castings, smoothing irons, mill-wheels and other articles re manufactured:" the road from Mexico to the valley of Cuernavaca nd Cuautla passes through it.

Similarly the rancho of Los Amates is on a line of traffic: according to astillo it is near to Iguala and on the road from Mexico to that town. s the railway from Mexico to Acapulco was planned to pass through both uernavaca and Iguala, those towns must be on a natural route to the acific coast.

The Ocatitlan (of Krantz) is probably the town of Ocotitlan, five miles

[1] *Elementos de Orictognosia;* segunda parte, p. 40.

south-east of the town of Toluca, and not as Burkart supposed Xocotitlan or Hocotitlan 15 miles north-west of Xiquipilco.

Ocotlan (of Castillo) is probably a mistake for Ocotitlan, for the Sierra de Ocotlan is not in the State of Mexico at all, but on the south-western border of the State of Morelos and about 30 miles south of Cuernavaca.

Tenango (of Krantz) is the capital of its district, and is only nine miles south of the town of Toluca.

Sizipilec (of Von Babo or Schleiden) is not given in the maps: from Sizipilec to Xiquipilco is at first sight too vast a transition to be due to error of transcription or printing, but when written in German cursive hand, the two words present such a close similarity that there can be no doubt at all of the name Sizipilec having come into existence in that way: the German *X* has become *S*, *qu* has become *z*, *co* has become *ec*. In fact most of the Toluca specimens got into the market through Schleiden, as is stated by Stein: and his remarks relative to the mode of occurrence at "Sizipilec" are identical with those made in the case of Xiquipilco.

A similar transformation from Xiquipilco to Tejupilco (of Krantz) in German, is easily possible; and indeed a printed label, sent by Krantz with a specimen to the British Museum, is altered in Krantz's handwriting from Tejupilco to Xiquipilco, showing that he himself accepted the view expressed by Burkart that there was a mistake in his original version of the name.

A Mexican specimen in the Poinsett Collection.

A specimen found in Poinsett's collection of Mexican minerals was analysed by Lawrence Smith, who suggested that it might belong to the meteorite of Charcas.[1] Poinsett published notes of a journey made through Mexico in 1822, and was for some time the United States Representative at Mexico City.[2] Burkart saw the Charcas mass soon after Poinsett's journey, and there were then no marks indicating the removal of a fragment. Poinsett makes no mention of meteoric iron in the notes of his journey. Everything points to the specimen being really one of the small masses from the Valley of Toluca: we may add that a specimen of the Toluca iron was sent to the Berlin Collection from the Embassy at Washington.[3]

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[1] *Amer. Jour. Sc.*, 1868, ser. 2, vol. 45, p. 77.

[2] *Notes on Mexico made in the Autumn of* 1822 (Poinsett), London, 1825.

[3] *Beschreibung und Eintheilung der Meteoriten zu Berlin* (G. Rose), 1864, p. 60.

Chemical Analyses of the Toluca iron.

Numerous analyses of Toluca masses have been made; the iron found various chemists varies from 85 to 92 per cent.: a table of the results been published by Buchner.[1]

VIII. State of Oaxaca.

In this State a large mass has been found at *Yanhuitlan:* identical with is are masses said to have been found at *Chalco* and *Cholula:* fragments the same mass are in the collections under the name of *Misteca.*

1. The Yanhuitlan mass.

El Mosaico Mexicano, 1840, vol. 3, p. 219, states:—

"The following is extracted from the information supplied by José pez Ortigoza, Governor of the Department of Oajaca. The town of nhuitlan is situated in the Misteca alta, at a distance of 4 leagues from poscolula. Near this town is a hill called in the Mistec language que-Yucunino: at its foot, according to the accounts of the oldest abitants, some Indian labourers, while tilling the ground, found an raordinary mass, which from the rarity of its characters attracted their ntion, and they carted it as far as the town: unable to learn its origin value they tumbled it into a corner where it long remained. Its shape d hardness induced Vicente Hernandez, the blacksmith, to transport it his smithy, and he used it as an anvil for some years. In 1825, F. Morney (*i.e.* Mornay), an Englishman, saw the mass, and not hout much difficulty cut off a piece which he afterwards analysed and nd to contain iron, nickel and silica. About the years 1826-30 it was moved from Yanhuitlan, and was to have been placed in the Museum of jaca: its great weight and the bad roads made the undertaking difficult, that at a short distance from Yanhuitlan the plan was given up, d the mass was left there. In 1832 the present Bishop of Puebla saw and also had a little piece cut off."

The mass, which weighed 421 kilos., was removed to the City of Mexico 1864, and minutely described by Castillo and Rio de la Loza.[2]

2. The Cholula mass.

Buchner,[3] in the continuation of his meteorite-list, says in 1865:—

[1] *Die Meteoriten in Sammlungen*, Leipzig, 1863, p. 141.

[2] *Bol. Soc. Mex. de Geog. y Estad.*, 1865, vol. 10, p. 661.

[3] *Pogg. Ann.*, 1865, vol. 124, p. 599.

"Cholula, Mexico. A meteoric mass of about 500 kilos. is said to have been just brought to the City of Mexico. From its weight it appears to be an iron meteorite. Further news is to be expected."

It is obvious from the above history, that the mass referred to by Buchner is really that of Yanhuitlan, and that there has been a confusion of the names Cholula and Teposcolula: in fact, Buchner omitted the Cholula mass from his later list of 1869.[1]

3. The Chalco mass.

Burkart,[2] however, in 1870, gave a list of Mexican meteorites, and among them:—

"Chalco, a town in the Valley of Mexico. No further news has been received relative to the iron meteorite of 500 kilos. which, according to Buchner (Pogg. Ann., vol. 200, p. 599), is said to have been taken to Mexico."

Buchner's statement is really in vol. 124, p. 599, and relates to the mass called by him Cholula; vol. 200 had not at that time (1870) been published.

Hence Chalco is a mistake for Cholula, itself a wrong version of Teposcolula, and the Chalco mass is identical with that of Yanhuitlan.

4. The Misteca Alta fragments.

Del Rio[3] (1804) mentions "La Misteca" as a locality for metallic iron. According to Humboldt,[4] "the Province of Oaxaca includes two mountainous districts which have been known since the most remote times under the names Mixteca and Tzapoteca. The ancient Mixtecapan is now divided into Upper and Lower Mixteca (Mixteca alta and baja). The Indians of La Mixteca are an active, intelligent, industrious people." As already stated, the town of Yanhuitlan is in Mixteca alta, and the large mass had been found long before Mornay noticed it in 1825.

In 1834, Partsch[5] acquired for the Vienna Collection a small piece of meteoric iron, and later stated as follows (1843):—

"From an Indian town in the Misteca, State of Oaxaca, Mexico. Relative to the existence of this meteoric iron nothing has hitherto been published. Freiherr von Karawinsky of Munich, who has repeatedly

[1] *Pogg. Ann.*, 1869, vol. 136, p. 605.
[2] *Neues Jahrbuch für Min.*, 1870, p. 692.
[3] *Tablas Mineralogicas*, p. 57.
[4] *Essai politique* &c., vol. 1, p. 263.
[5] *Die Meteoriten zu Wien*, 1843, p. 134.

avelled about Mexico, brought the piece back with him. It was
t from a mass which lies in the above mentioned place, as he informs me
y letter."

It is clear that the mass referred to by Karawinsky must be identical
ith the one which at that date was still lying near the Indian town
Yanhuitlan.

Burkart,[1] having applied to Drusina for a specimen of the Misteca iron,
ceived a fragment in 1855, but got no information as to the exact
cality: Castillo (1889) says that he himself gave the specimen to
rusina to be sent to Burkart, and is of opinion that it may be the
uncated point of the Yanhuitlan mass.

It is obvious that all the fragments known as Oaxaca or Misteca have
en cut from the single mass found near the town of Yanhuitlan, and that
e existence of the mass was already known in the Capital in 1804.

The following analyses have been published:—

	Misteca.		*Yanhuitlan.*	
	Bergemann.[2]	Rammelsberg.[3]	Rio de la Loza.	Rammelsberg.[3]
	1857.	1869.	1864.	1869.
	S.G. 7·58	S.G. ——	S.G. 7·82	S.G. ——
ron	86·86	——	96·58	——
ickel	9·92	4·39	1·83	6·21
obalt	0·74	0·18	0·36	0·27
alcium... ...	——	——	0·61	
hosphorus ...	0·07	——	——	
ulphur	0·55	——	——	
esidue	0·97	0·20	0·01	trace.
	99·11		99·39	

The results furnish another striking example of the impossibility of employing, for discriminatory purposes, percentage compositions assigned by different chemists on the basis of analyses made in different ways on different fragments of meteoric iron, which is always a more or less complex mixture of various chemical compounds: in the present case, the difference is doubtless chiefly due to the difference in the processes employed; Rio de la Loza called attention to the fact that some of the reactions, observed but not specified by him, were of so unexpected a character as to suggest the presence of an unknown substance.

[1] *Neues Jahrbuch für Min.*, 1856, p. 305.

[2] *Pogg. Ann.*, 1857, vol. 100, p. 246.

[3] *Zeitsch. d. deutsch. geol. Gesell.*, 1869, vol. 21, p. 83.

IX. State of Guerrero.

The Caparrosa mass.

Castillo[1] in 1858, on breaking a piece of copper pyrites which had been brought from the Rincon de Caparrosa, south-west of Chilpancingo, State of Guerrero, found a nodule of metallic iron, weighing 341 grams, embedded in it. He reports that it shows Widmänstatten figures when etched, and that the copper pyrites occurs in a talc-schist.

A specimen discovered under such extraordinary circumstances, if really of meteoric origin, is worthy of a more minute examination and description.

Summary as regards the dispersion of Mexican iron masses.

In each of the States of Zacatecas, Oaxaca and Guerrero, only a single mass of meteoric iron has been found, and there is absolutely nothing to suggest that they do not represent independent falls.

In Sinaloa, likewise, only a single mass has been met with, and its characters have not been determined: a suggestion of a relationship with another group would rest on the slight fact that the site of an extremely large mass is in a straight line with two other sites where large masses are now lying.

In San Luis Potosi two localities are recognised, but there is a strong probability that the Charcas mass, which has undoubtedly been transported to that town from a distance, was brought from the neighbourhood of Catorce: and, even if this was not the case, there is no evidence that the mineralogical characters are such as to render separate falls improbable.

In Durango four or five distinct localities are known, but the characters of the only masses which have been examined point unmistakably to the falls of distant masses having been independent of each other.

In Mexico there has undoubtedly been a large shower of limited dispersion in the Valley of Toluca: the three remaining masses from Mexico and Morelos have not been examined, and are very small and portable: even if they have not been transported, they may be found on examination to present characters which will differentiate them from the masses of the Toluca shower.

From Coahuila many masses have been got, but it is extremely probable

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[1] *Cat. Des. cit.*, p. 1; *Verh. d. naturh. Vereines d. preuss. Rheinl. u. Westph.*, Jahrg. 22, Sitz. Mai 4, 1865, p. 72.

all of them were brought from a single district of very small area: wo Nuevo Leon masses have never been examined and had obviously t transported, perhaps from Coahuila or San Luis Potosi.

Chihuahua three or four areas are represented: but of the masses l in that State only those of the Huejuquilla group have been ined, and that in a very incomplete way: the recognition of the ness of the fall of the Huejuquilla group depends almost entirely on eneral similarity of appearance of the large masses. If the masses belong to a single fall, as the available information makes most able, the maximum dispersion is now 66 miles: but one of the terminal es, that of San Gregorio, is known to have been transported by the iards on one occasion for 1½ leagues, while according to a tradition nt three centuries ago it had accompanied the Indians when they eyed southward to take possession of that part of Mexico.

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A Visit to the Calcite Quarry in Iceland.

By J. L. Hoskyns-Abrahall, Esq.

[Communicated by the Secretary.]

[Read March 18th, 1890.]

the summer and autumn of last year I paid a visit to Iceland, and as I had been told by my friend, Mr. Madan, that the difficulty of obing large pieces of clear calcspar for optical purposes had been exciting e curiosity as to the state of the quarry itself, and as the peculiarity of deposit made it an object of interest, I thought it worth while to e Eskifjördhr[1] into my route. The narrow fjords of Sudhrmúla Sysla, hich Reydharfjördhr, the largest, bisects the East coast of Iceland, are out of an immense plateau, formed of horizontal sheets of volcanic —chiefly trachyte—between three and four thousand feet high. has been subsequently eroded into sharp bare ridges with immense or steep slopes falling from them, parted by torrent valleys and ds; the greater part of the district not reaching the present snow-line. on one of these slopes, which slants down at an angle of forty degrees Reydharfjördhr, that the unique quarry of Iceland spar is found. It ists of a cavity in the rock about twelve yards by five, and some ten high, originally filled almost entirely, but now only lined, with ense crystals, which are fitted so closely together as to form a compact s, like a lump of sugar with grains averaging ten inches across.

he Syslumadhur,[2] Jón Asmundarson Johnsen, had given me leave xamine the cave, and take as many specimens as I liked; but the ission was not of very much use, there being about five feet of water ly all over the bottom; and such specimens as I did get involved g severe penance in walking barefoot over the sharp crystals. The is covered with a thin layer of very fine chocolate-brown mud, h sticks as tenaciously to one's feet as to the crystals. I had to

[1] (dh = th in with.)

[2] Magistrate, public notary, receiver of taxes, liquidator, auctioneer, &c.

resort to tooth-powder to get the latter clean, though the great heaps
spar which lie on the path-side and in front of the mouth of the cave we
all washed by the rain till they were as bright and transparent as ic
The water now running through the cave is incapable of forming calcspa
It appears, like the surrounding rocks, to contain an excess of silicic aci
and either etches the surface of the spar wherever it comes in conta
with it, or covers it with stilbite, the characteristic zeolite of the dolerit
and basaltic rocks in Iceland. The rock in which the cave is formed
a dolerite, and darker in colour than the surrounding phonolite, whic
is traversed by veins of black and green pitchstone. In the neighbou
hood of the spar it is disintegrated, coloured slightly with green-earth
and full of microscopic crystals of stilbite and calcite.

The quarry was worked till 1872 by Herra Tulinius, a Danish merchan
of Eskifjördhr—the trading station is an hour and a half's ride fro
Helgastadhir, the nearest farm to the quarry. (In Iceland all distances a
measured in terms of the hour's ride, *tima*, and the day's journey, *leidh*
The Icelandic government in that year bought a quarter share of th
quarry, and stopped the work, so that Tulinius was glad to sell them th
rest. Five years ago an attempt was made to re-open it. One man wa
employed, and after spending about a week in the cave, he succeeded i
pumping out the water and extracting a fine block of clear spar, whic
was sold at a high price in London. Here, however, the work droppe
and in consequence Tulinius remains the proprietor of the whole of th
calcspar that is available for physical work, and naturally sells it at
price that is calculated to make his very moderate stock last for a co
siderable time.[1] The reason of the inaction of the Icelandic governme
is not very clear, but as the working of the quarry is, perhaps fro
patriotic motives, delegated to Herr Gunnarsson, an *Icelandic* merchan
whose nearest warehouse is at Seydhisfjördhr, a good day's ride fro
Eskifjördhr, it is hardly to be expected that the buried treasure will soo
see the light. Perhaps too the specimens of the best quality ha
been already removed. Certainly clear pieces do not constitute the gre
mass of the spar, and if M. Labonne, who visited the cave in May 187
(the water being at that time frozen), could extract it 'en ass
grande abondance' (*Comptes Rendus*, 105, 1144, 1887), he did n
leave much exposed for me to take two years later. M. Labonne speal
in his note of ramifications into the environing rock which have nev
been worked, and suggests that this investigation might increase th

[1] It is sold by Thor E. Tulinius, Slotsholmsgade 16, Copenhagen K.

tance of the quarry; such ramifications as I could see were on a mall scale. On the other hand, the thickness of the deposit has not en ascertained. But it is said that the best pieces occurred near rface. For the most part the calcite is rendered semiopaque by nerable cracks, generally following the gliding and cleavage planes ? and *R*), and apparently produced by the pressure of the spar itself, metimes following the conchoidal fracture: remarkable examples of tter kind are in the British Museum.

Sanguinite, a new Mineral; and Krennerite.

By H. A. Miers, M.A.

[Read March 18th, 1890.]

(*a.*) *Sanguinite, a new Mineral.*

THIS mineral was found upon several specimens of argentite fro Chañarcillo which were acquired for the British Museum 1886.

The specimens consist of argentite in large drusy octahedra implant on quartz or calcite, and associated with proustite and a little asbest

The proustite is mostly in the form of small brilliant prisms wi scalenohedral terminations $\{20\bar{1}\}$, capped by the rhombohedron {11 which are grouped upon the argentite. But dispersed on the argenti together with these crystals of proustite, are a number of fine glitteri scales, which present at first sight precisely the appearance of t pyrrhosiderite or göthite of Siegen, having the same bronzy red colo and a lustre resembling that of earthy haematite when seen on the matr that is to say partly by reflected and partly by transmitted light. Un the microscope the scales are easily distinguished from göthite; they without striations, remain dark when rotated between crossed nicols, a appear of a nearly blood-red colour by transmitted light; whereas sca of göthite are striated in one direction, and exhibit marked differences absorption when rotated above the polariser.

Sanguinite was subsequently found on an older specimen in the Brit Museum Collection which had been supposed to be göthite or fireblen On this specimen the scales are associated with calcite, argentite pa converted into silver, and a little copper pyrites, but no proustite. T intimate association of the scales with proustite, their colour, their obvious derivation as an alteration-product from argentite sugg that they are probably a sulph-arsenite of silver, a conclusion wh is fully supported by the necessarily incomplete chemical examination.

A quantitative analysis is precluded by the paucity of materi the scales are so excessively thin that although they are very conspicu

the specimens owing to their brightness and colour, the whole moved would probably weigh no more than a few milligrams. Some tative experiments have however enabled Mr. Prior and myself rove the presence of sulphur, arsenic and silver. The material was fully picked out scale by scale under the microscope and examined een crossed nicols, so that it was known to be free from proustite and ntite.

is with difficulty soluble in strong nitric acid, behaving in all respects proustite; the solution of several scales gave a perceptible precipitate hydrochloric acid, soluble in ammonia.

bout 50 of the scales, weighing altogether less than ·0003 gram, fused sodium carbonate and potassium nitrate, and tested in the usual way sulphate, gave a very evident precipitate with barium chloride. at the same quantity tested for arsenic by the Fresenius-Babo method a very distinct arsenic mirror; in the residue minute particles metallic silver were visible, and treated with nitric acid it yielded lky liquid containing silver cyanide, which became clear on addition of monia.

he only known minerals to which the scales might apparently be rred are proustite, xanthoconite, and the mineral from Chañarcillo ribed by Streng (*Neues Jahrb.* 1878, p. 917; and 1879, p. 547). physical characters, however, so far as they can be observed, are as ows:—

olour, by reflected light, black; by transmitted light, almost identical that of proustite, but darker (Radde 1 h to 2 k), and yellowish red he thinnest scales. Streak (colour of the powder), dark purplish wn (Radde 30 b nearly).

rystalline system hexagonal or rhombohedral; fracture conchoidal.

he scales have a brilliantly reflecting surface, but are rarely oth plates, being almost always curved and slightly crumpled. They usually broken at the edges with a curved fracture, but are sometimes e found with sharply defined rectilinear edges, which meet at an angle 0°; there can be no doubt that they are true uniaxial hexagonal plates, hey remain dark between crossed nicols when viewed in the direction heir normal, but when tilted in any way are seen to be doubly acting with an extinction which is always parallel to the normal.

he sign of the double refraction could not be determined on account of extreme thinness of the scales; their average thickness is not e than 0·001 mm., and when 4 or 5 plates are superposed they become opaque for optical examination.

Sanguinite is completely distinguished from xanthoconite, and Streng's mineral (which is probably either fireblende or rittingerite), by its colour, streak, and optical character; these characters are also sufficient to distinguish it from fireblende, which it somewhat resembles, and from rittingerite.

The distinction between sanguinite and proustite may seem less conclusive, since both are sulpharsenites of silver, hexagonal, uniaxial, and almost identical in colour by transmitted light.

On the other hand proustite never occurs in anything resembling hexagonal scales; in fact the basal plane does not exist as a smooth surface on the mineral; moreover, the proustite associated with sanguinite, which has apparently been formed contemporaneously with it by the alteration of the same crystals of argentite, is of the usual habit.

Finally, the streak of sanguinite is a dark purplish brown, somewhat like that of miargyrite, but darker, and quite different from the streak of proustite, which is, as I have shown, so characteristic as to distinguish that mineral with certainty even from arsenical pyrargyrite.

Another specimen from Chañarcillo consisted of 6-sided scales, having very much the appearance of sanguinite, grouped upon calcite with a little proustite. These, however, were found to be darker in colour than the sanguinite, and between crossed nicols show a bisectrix in the centre of the field, and indications of two optic axes; they also display a twin lamination which is never found in sanguinite.

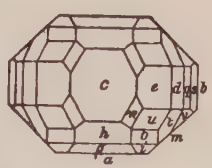
Their striking resemblance to that mineral suggests that they may be the corresponding sulphantimonite, especially as their colour is almost exactly that of pyrargyrite.

Possibly they may be referred to fireblende or rittingerite.

(*b.*) *Krennerite.*

Only three crystals of this rare telluride of gold from Nagyag have previously been measured; one by Krenner (*Ann. f. Phys. und Chem.*, vol. i. 1877, p. 636), who described the mineral under the name of Bunsenin; another by vom Rath (*Zeits. f. Kryst.* i. 1877, p. 614), who substituted the name Krennerite; the third by Schrauf (*Zeits. f. Krys.* ii. 1878, p. 235). Their observations lead to axial ratios, which do not differ much either from each other or from those adopted by myself.

The following description of a crystal taken from a specimen in the British Museum Collection supplies confirmatory measurements, and contributes 6 new forms to the 16 previously recorded.



In this specimen the Krennerite occurs small striated prisms upon crystallised rtz, together with a little iron pyrites and ne small crystals of tetrahedrite which are ted with copper pyrites; most of the sms are terminated by the bright and racteristic basal cleavage plane; the one which was measured pre- ted 10 forms which have previously been observed, namely:—

a	010	$\infty\breve{P}\infty$	*o*	111	P
c	001	0P	*i*	232	$\frac{3}{2}\breve{P}\frac{3}{2}$
m	110	∞P	*h*	011	$\breve{P}\infty$
e	101	$\breve{P}\infty$	*p*	021	$2\breve{P}\infty$
u	212	$\breve{P}2$	*b*	100	$\infty\breve{P}\infty$

l six new forms, namely:—

d	201	$2\breve{P}\infty$	*t*	211	$2\breve{P}2$
q	301	$3\breve{P}\infty$	*v*	632	$3\breve{P}2$
s	401	$4\breve{P}\infty$	*w*	214	$\frac{1}{2}\breve{P}2$

This prism was 0·5 mm. long and 0·75 mm. broad.
The axial ratios obtained from the measurements are

a : b : c =	...	1·0651 : 1 : 0·5388
Krenner found	...	1·0661 : 1 : 0·5440
vom Rath found	...	1·0630 : 1 : 0·5362
Schrauf found	...	1·0643 : 1 : 0·5399

Of the remaining six forms previously observed, which are not found on s crystal, it may be remarked that four belong to the prism zone in ich the faces are vertically striated and scarcely capable of exact asurement; the terminal faces are bright and smooth. The following le contains all the reliable measurements of Krenner and vom Rath:—

	Miers.		Krenner.		vom Rath.	
	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.
	° ′	° ′	° ′	° ′	° ′	° ′
c e	26 50	..	27 0	27 2	..	..
c h	28 19	..	..	..	..	28 12
c d	45 20	45 20	..	..	..	..
c q	56 35	56 37	..	..	..	..
c s	63 48	63 42	..	..	..	..
c o	46 52	47 8½	..	..	..	..
a i	54 11	54 12	..	..	54 30	54 19
a o	64 21	64 19	..	..	64 15–30	64 24
a u	76 27	76 29	..	76 23	76 30	76 32
e u	29 47	29 49	30 5	30 2	..	..
a m	43 5	43 12	43 10	..	43 15	..
c t	49 4	48 54	..	..	..	..
c v	59 52	59 49	..	..	..	..
c w	15 58	15 59	..	..	..	..
c m	..	72 0	71 53	..	72 1½	..
e u	13 33	13 31	13 41	13 37	..	..
m u	..	61 55	61 46	61 42½	..	..
u u	..	52 14	52 20	..	..	..
i h	23 56	23 51	..	..	..	..
h u	29 2	29 0	..	..	..	..
u d	22 44	22 46	..	..	..	..
c o	36 26½	36 28	..	..	..	..

Notes on Bowenite or Pseudo-Jade from Afghanistan.

By Major-General C. A. McMahon, F.G.S.

[Read May 20th, 1890.]

STONE called *sang-i-yashm*[1] in Persian, which has some points of resemblance to jade and is sometimes mistaken for it, is utilised at ra, in the Shahpur District of the Panjab, for the manufacture of ger hilts, knife handles, caskets, amulets, and other articles. It lso found useful in mosaic work.

am indebted to Mr. J. Wilson, B.C.S., Deputy Commissioner of the hpur District, for several specimens of the stone in the unworked e, and for information regarding its place of origin. Other specimens tained from my son Lieut. A. H. McMahon, Assistant Commissioner, hat.

The *sang-i-yashm* is a hard species of serpentine which seems to respond very closely to that named bowenite, after Dr. Bowen, who, in 22, published an analysis[2] of a mineral from Smithfield, R.I., which up that date had been called nephrite.

In 1853 the Smithfield bowenite was re-examined by Messrs. J. wrence Smith, M.D. and George J. Brush,[3] who proved its identity h serpentine.

The hardness of the Smithfield mineral was said by Dr. Bowen to equal to that of felspar. J. D. Dana put it at 5·5 to 6, E. S. Dana 5·5, and Smith and Brush at 5. The Afghan mineral has a hard- s of 5.

The Sp. G. of the Smithfield bowenite, according to Dr. Bowen, varies n 2·59 to 2·787. I found 2·59 to be the Sp. G. of the Afghan neral.

The following analysis (No. I.) of the Afghan *sang-i-yashm* was made in British Museum Laboratory by Mr. G. T. Prior, M.A., and has been dly communicated to me by Mr. Fletcher, F.R.S., the Keeper of Mineralogical Department. I also give for facility of reference . Bowen's analysis (No. II.) and Smith and Brush's analyses (Nos. . IV. and V.).

Sang means stone. *Yashm*, according to Forbes's and Platt's dictionaries, is a per "especially from China, supposed to be an infallible charm against lightning."

Amer. Jour. of Science. 1st Series, V. 346 (1822).

Ibid. 2nd Series, XV. 212.

	I.	II.	III.	IV.	V.
Silica	44·73	44·69	42·20	42·56	42·10
Magnesia	42·64	34·63	42·50	43·15	41·23
Alumina	0·32	0·56	trace	trace	trace
Ferrous Oxide ..	0·33	1·75	1·56	0·95	1·11
Lime	trace	4·25	trace	..	1·90
Manganese	..	trace	..	..	..
Water	12·21	13·42	13·28	12·84	12·77
	100·23	99·30	99·54	99·50	99·11

The theoretical formula for serpentine is: magnesia, 43·48; silica, 43·48; water, 13·04. The analysis of the Afghan mineral comes very near this standard, and corresponds closely with the analyses of American bowenite made by Smith and Brush.

As regards the lime found in bowenite by Dr. Bowen, Smith and Brush remark :—"The large amount of lime obtained was doubtless due to the limestone and tremolite with which it is often very intimately associated; much care is required to separate those substances entirely from the bowenite, but the mineral so purified, contains no lime."

The colour of the Smithfield mineral is said by Bowen to be "bright apple-green, sometimes tinged with blue;" and by J. D. Dana to be "apple-green or greenish white."[1] My specimens of the Afghan rock vary in colour from a dark greenish grey to a very pale sea-green mottled with white. Some specimens are said to be delicate apple-green.

The Smithfield mineral Dr. Bowen tells us is found "in large nodules" imbedded in "white primitive limestone." The Afghan bowenite appears to occur in rock masses at the head of one of the mountain gorges that run down from the Safed Koh into the valley of the Kàbul river. A man of Bhera, from whom Mr. Wilson derived his information, "went in search of the stone about forty years ago. He says he proceeded to Gandàmak[2] on his way to Kàbul, and from thence travelled up a gorge to the south for about thirty miles. At the head of the gorge he came to a rock where there are great quantities of the stone." "It is sold on the spot at about Rs. 2/8 to 3 Rs. a maund (5 shillings the cwt.). Some of the bits at Bhera have two marks of blasting bores on them. They weigh up to a cwt." After import to Bhera in the Shahpur District of the Panjab it is sold by weight "at about Rs. 40 per maund, or 74 shillings per cwt., and the inferior quality at 10 Rs. per maund, or 18 shillings per cwt. There are only three shops in Bhera of the workers of the stone, and they have between them used up about 5 maunds in three years."

[1] *System of My.*, 1882, p. 465.

[2] Gandàmak is between Jalàlàbàd and Kàbul.

he *sang-i-yashm* is partially decomposed by hydrochloric acid, and mpletely decomposed by hot concentrated sulphuric acid on prolonged stion.

Then a thin slice of the Afghan bowenite is examined under the roscope between crossed nicols it breaks up into a mass of minute ly refracting fibrous crystals standing out against a dark background; latter being due in part to the over-lapping of felted fibres, and equent compensation, and in part to the extinction of such of crystals as lie in the same azimuth as one or other of the crossed ls.

Whenever the cleavage of the original mineral from which the bowenite been derived can be made out, one set of doubly refracting fibrous tals are found to lie parallel to it. A second set may be observed at t angles to the first; whilst a third more sparsely distributed series rystals may also be seen, which indicate that the parent mineral essed a third, and less easy cleavage, diagonal to the other two.

n other parts of the thin slices examined the crystals assume a some- t feathery appearance, or arrange themselves in sheaf-like sprays. In e slices the doubly refracting crystals are somewhat micaceous, and entral portions of them exhibit a marked but discontinuous cleavage. se micaceous crystals cannot be talc, inasmuch as they never exhibit urs higher than the blue, yellow, and red of the first order of Newton's e and no parts of the slices have a hardness of less than 5.

. D. Dana in his System of Mineralogy remarks :—"If marmolite or rmophyllite is truly crystallized serpentine, as seems probable, the tallization of the species is actually micaceous like that of chlorite and ."

n the whole I see no reason to doubt that all the doubly refracting ions of the thin slices of bowenite examined are true serpentine. en thin slices of the rock are digested in sulphuric acid, the fibrous cture of the mineral is well brought out.

he optical properties of the doubly refracting crystals of bowenite cide with those of serpentine. Extinction is uniformly straight; the or axis is normal to the axis of the fibres; and the crystals that ibit cleavage, or fibrous structure, do not yield a bisectrix in converging arised light. The refractive index of the Afghan mineral is evidently e to that of Canada balsam.

The *sang-i-yashm* appears to be a very pure serpentine. In some slices ew microscopic dots of magnetite may be made out, and some roscopic crystals of pyrites. There are also scattered through the slices

granules of a mineral which either remains absolutely dark when revolved between crossed nicols or only shows the feeblest possible glimmer, which may be due to the under-lapping of some of the serpentine. It does not exhibit crystallographic outlines or definite cleavage. It has a rough and cracked surface; it frays out at the ends into needles, and does not exhibit any metallic lustre. It has a high refractive index, and appears to be insoluble in sulphuric acid. In some respects it looks like garnet, but it does not possess the habit of that mineral. Sometimes it occurs in strings in a way to suggest that it is a secondary product; at other times it is penetrated by channels of serpentine very much in the way in which remnants of olivine are found in serpentine. On the whole I am disposed to think that it represents one of the original constituents of the parent rock, and possibly may be a pseudomorph after olivine. I hesitate to give the mineral a definite name.

This mineral, whatever it is, leads to the consideration of the character of the parent rock. The fact stated above relative to the structure of portions of the bowenite indicates that one of the minerals of the original rock possessed a triple cleavage, the two principal planes of which were at right angles to each other: a circumstance which enables us to identify it as pyroxene.

There is no evidence, beyond the suggestion as to olivine alluded to above, to show what the other constituents of the parent rock were, but there is nothing in the microscopic evidence to negative the supposition that the principal one was olivine. The almost complete leaching out of the iron destroyed all trace of *Maschen-structur;* but we must suppose that the original rock was, to a considerable extent, made up of a magnesian mineral, as otherwise the magnesia of the pyroxene of which the rock was evidently in part composed, could hardly have been levelled up to the amount required for its conversion into serpentine.

On the whole the probabilities of the case are in favour of the parent of the Afghan bowenite having been, as in the ordinary run of serpentines, some variety of peridotite.

The conversion of the original rock into pure serpentine has been so complete, that little microscopic evidence remains of the mode in which the aqueous agencies that effected the change in the rock worked their way through its molecular structure. Still there is enough to show that these agents availed themselves of all the facilities that existed; a few straight cracks with microscopic deposits of iron along their margins may, on careful search, still be traced; and, as before stated, when cleavage planes existed the serpentine crystals were formed in alignment with those planes

The curved, feathery, and sheaf-like crystals were probably formed in the olivines of the parent peridote; curved cracks are commonly observed in this mineral, but regular cleavage is rarely, if ever, seen in sections made for the microscope. Other indications of aqueous agents may be noticed in the occasional deposit of a substance, reddish brown in reflected and transparent in transmitted light, that *runs with* some of the feathery sprays of crystalline serpentine. This reddish brown substance is evidently a secondary product, and it helps to throw light on the mode in which the curved and feathery crystals of serpentine were themselves formed.

On the Relations between the Gliding Planes and the Solution Planes of Augite.

By Professor John W. Judd, F.R.S., F.G.S.

[Read May 20th, 1880.]

NONE of the mineralogical problems of the present day are of greater importance than those which deal with the nature and causes of the modifications which crystallised bodies undergo as a consequence of changes in their environment. It is above all things necessary that we should clearly discriminate in every case between the characters of minerals which are *original* and *essential*, and those which are *accidental* and *secondary*, and which result from the action of various mechanical and chemical forces upon crystals, subsequently to their formation. No fact is more certain than that crystallized minerals, without losing their identity, may have their chemical composition altered within certain (often very wide) limits; and that, as the result of chemical action or mechanical strains, profound changes may take place in all their optical and other physical properties.

It has long been known that certain augites—especially varieties pale in colour and poor in alumina and iron—often exhibit a lamellar twinning parallel to the basal plane {001}. These varieties, which are especially abundant in crystalline limestones, are also found in certain igneous rocks; and Rosenbusch proposes to group them under the name of malacolite. In 1886, Mügge showed that when untwinned crystals of this variety of augite (which he calls diopside) are subjected to deforming stresses by Daubrée's method of enclosing the crystal in lead and subjecting it to pressure, lamellar twinning on the basal plane was produced artificially. The varieties operated upon by Mügge were the well-known malacolites (diopsides) of Ala and Achmatowsk.[1] As long ago as 1827 a distinguished pioneer in crystallographic research, William Phillips, showed that the Whin-Sill of Teesdale contains an augite, which besides

[1] *Neues Jahrb. für Min. &c.* 1886, I. p. 185. *Ibid.* 1889, I. p. 238.

senting a somewhat unusual development of certain faces, also exhibits mellar structure parallel to the basal plane.[1]

n 1875 Dr. Hawes described an augite occurring in a diabase from the nnecticut Valley, which exhibits the same structure.[2] An analysis was en of this variety by Dr. Hawes, and a section reproduced by pho- raphy is contained in Rosenbusch's well-known work.[3]

n 1884, Dr. Osann showed that an augite with lamination parallel to basal plane occurs at Költer and other localities in the Faroe nds, and that this is really a variety, like that of the Connecticut ley, rich in iron and magnesia. In the same year Mr. Teall re- mined the augites of the Whin Sill, and showed that Phillips's deter- ations were correct; he also proved that in chemical composition se Whin-Sill augites agree very closely with those of the Faroe Islands cribed by Osann,[4] and those of the Connecticut Valley described by wes.

n my study of the rocks of the Western Isles of Scotland, I have found augites exhibiting a lamellar structure parallel to the basal plane are emely common, especially in Ardnamurchan, both among the older iary lavas (those erupted before the basalts of the plateaux) and in se of newer tertiary age (lavas that made their appearance at the sur- subsequently to the basalts). These augites agree very closely with forms described from the Faroe Islands by Dr. Osann. They differ n those described by W. Phillips and Mr. Teall in rarely, if ever, ex- ting the simple twinning parallel to the orthopinacoid {100}, and thus "herring-bone" structure of Mr. Teall is very seldom seen in them. My study of the Scottish gabbros long ago led me to the conclusion the lamination parallel to the orthopinacoid, which is found in diallage, the result of chemical action, taking place at great depths, along ain definite planes (solution-planes) in the crystals of ordinary augite.[5] showed that the planes first acted on are those parallel to the opinacoid {100}; that next the planes parallel to the clinopinacoid affected {010}; and that finally a similar action is set up along the es parallel to the base {001}. In this way the structures are tually produced which characterise the so-called "pseudo-hypersthene."

Camb. Phil. Trans. Vol. II. p. 166. *See also* Phillips's Mineralogy, 3rd ed. (1823),).

Am. Journ. Sc. 3rd ser., Vol. IX. (1875) p. 187.

Mikroskopische Physiographie der petrographische wichtigen Mineralien, 2nd on (1885), table xix. fig. 6.

Quart. Jour. Geol. Soc. Vol. XL. (1884) pp. 647-8.

Quart. Jour. Geol. Soc. Vol. XLI. (1885) p. 367.

Every petrographer is familiar with the fact that the common twinning of augite upon the orthopinacoid {100} shows a tendency towards repetition, so that we find one or more twin-lamellæ running through the middle of the crystal. Recently Professor Renard, in his studies of the rocks of Teneriffe, has been able to show that numerous twin-lamellæ are sometimes formed parallel to the orthopinacoid, there being a curious tendency towards the crowding of the twin-lamellæ towards the middle of the crystal.[1]

These facts, showing the intimate relation which exists between the simple twinning of a crystal and the lamellar twinning which may be brought into existence by mechanical means, are of very great interest.

Now it is a very interesting circumstance that in some of the most highly crystalline varieties of andesite from Mingary Castle, in Ardnamurchan, we find in the porphyritic augites the planes of alteration parallel to the basal plane well developed, and the commencement of a second plane of lamination parallel to the orthopinacoid.

Let us proceed to consider the explanation of these facts. Even if the view put forward by Van Werveke,[2] and to some extent supported by Rosenbusch, be the true one, that the lamellar structure in diallage is itself determined, in the first instance, by pressure, then we must conceive of augite as being capable of lamellar twinning either parallel to the basal plane or to the orthopinacoid. If the former are produced, chemical action results in the formation of a laminated augite like that of Teesdale, Connecticut, Faroe, and Ardnamurchan. But if the latter are produced, then the result is an ordinary diallage. If this explanation be the true one, then there is a very remarkable analogy between the lamellar twinning of the augites and that of the plagioclases.

That augites exist with two systems of lamellar twinning, one parallel to the orthopinacoid and the other to the basal plane, and hence cutting one another at a high angle, I have been able to satisfy myself upon many occasions. Beautiful examples of the kind occur among the pale coloured augites in the "hemithrène" (red marble) of the island of Tiree. Some of the sections of these doubly twinned augites exhibit the most startling resemblance to sections of plagioclase felspars, with both albite and pericline twinning; so that but for their higher refraction and double refraction, mistakes might easily arise in their identification.

In 1886, I showed by experiments with calcite that when lamellar

[1] Report on Rock Specimens collected on Oceanic Islands. *Challenger Report, Physics and Chemistry*, Vol. II. (1889) p. 1.

[2] *Neues Jahrb. für Min. &c.* 1883, II. p. 97.

nning has been developed in a crystal, the gliding planes become the olution-planes," which are first attacked, in preference to the normal ution-planes of the crystal.[1]

These considerations enable us, I believe, to give a complete explanation the curious anomalies presented by augite-crystals. If, as I incline to ieve, the orthopinacoid {100} is the principal normal solution-plane of gite, then chemical action operating at great depths along planes parallel he orthopinacoid, leads to the development of secondary inclusions along m and results in the formation of ordinary brown diallage. If, as mical action becomes more intense with increased pressure, a second ution-plane is attacked, this is the clinopinacoid {010} ; and next the rd plane of chemical weakness, the basal plane {001}, is subjected to same action. Thus in the end we get pseudo-hypersthene.

But if, previously to the commencement of chemical action, lamellar nning parallel to the basal plane has been set up by pressure, then s becomes the first solution-plane, and is attacked before the normal ution-plane—the orthopinacoid.

As the result of the development of gliding planes parallel to the base, the chemical action which takes place along them, the augite-crystals he much altered rocks of Mingary Castle are often found broken up fragments, which are more or less displaced, and thus a curious ted appearance is given to the crystals.

In many cases, too, the development of the enclosures along the planes cked has been followed by still further and very profound alteration ; oritic and serpentinous products being formed in abundance along these nes. These much altered augites have just the same relation to the altered ones that the green diallages have to the ordinary brown llage.[2]

It is often asserted that the diallagic modification of augite is deter- ned by a peculiar chemical composition ; and a similar suggestion has n made in the case of those augites which present a laminated ucture parallel not to the orthopinacoid, but to the basal plane. But these conclusions I must confess that I am totally unable to find any rant. The pale green diopside of Rum, containing only 5 per cent. of n-oxides, assumes the diallagic condition equally with the dark black

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[1] *Mineralogical Magazine*, Vol. VII. (1886) p. 81.

[2] The altered augites of Mingary Castle are figured in Plate XIV. figs. 1 and 2 of . XLVI. *Quart. Jour. Geol. Soc.* (1890). Professor G. H. Williams has recently ed attention to the importance of a similar parting parallel to the basal plane ch is found in the hornblende of St. Lawrence County, New York. *Am. Jour.* ser. iii. Vol. XXXIX. (1890) p. 352.

augites of Loch Scavaig, in Skye, with 15 per cent. of iron-oxides. Indeed, every variety of augite, so far as my experience goes, may be found, when subjected to the proper conditions, to assume the diallagic modification. In the same way, the twinning and chemical alteration parallel to the basal plane is found equally developed in the pale coloured, slightly ferriferous malacolites and in the black, highly ferriferous augites of Teesdale, Költer, and Ardnamurchan. This is illustrated by the following table :—

COMPOSITION OF AUGITES EXHIBITING LAMELLAR TWINNING PARALLEL TO THE BASAL PLANE (001).

	Achmatowsk. *Hermann.*	Ala. *Wackenroder.*	Whin Sill. *Teall.*	Költer. *Osann.*	Connecticut Valley. *Hawes.*
Silica	53·97	54·15	48·41	50·21	50·71
Alumina	—	0·20	4·05	3·24	3·55
Ferric Oxide	—	—	2·36	—	—
Ferrous Oxide ..	2·00	2·51	15·08	17·40	15·30
Manganous Oxide ..	—	0·18	0·37	—	0·81
Lime	25·60	24·74	15·98	13·92	13·65
Magnesia	17·86	18·22	12·14	14·05	13·63

These analyses prove conclusively that a tendency to the development of lamellar twinning parallel to the basal plane is not confined to any one variety of augite. It is equally certain that the separation along the planes parallel to the ortho pinacoid which is characteristic of diallage is found alike in aluminous and non-aluminous augites, and in varieties with different proportions of lime, magnesia, and ferrous oxide.

For the sake of clearness, it is very desirable that a tendency to separation along certain planes in a crystal, which has been developed by mechanical action, (gliding planes) or by chemical operations (schiller planes), should not be confounded with the original planes of least cohesion (cleavage planes). Nothing can be more incorrect or misleading than to speak of diallage as a variety of augite which exhibits an additional "cleavage"; or murchisonite as a variety of orthoclase which exhibits a new "cleavage." The induced structures in these minerals have nothing whatever in common with the original structure of the crystals, which gives rise to their characteristic tendency to break up parallel to certain planes, and is indicated by the term "cleavage."

REVIEW.

Gems and Precious Stones of North America: by George Frederick unz. New York (*The Scientific Publishing Company*), 1890.

This work has an object which is clearly set forth by the author in his troduction. It is not a complete treatise on Precious Stones, or on the ience of Mineralogy, but relates almost solely to those precious stones nich have been found in North America. A brief general description d a series of recent analyses is given in each case: but the real object to collect together all the known facts which bear upon the occurrence precious stones in that part of the New World—such as the localities in nich and the conditions under which they occur, the methods by which e search and mining for them are conducted, the value and amount of oduction; and to present these facts in a form which will render them ailable, not only for the mineralogist, miner, collector and jeweller, but so for the general public.

For the preparation of such a work the author is unusually well fitted, d has had excellent opportunities. His lengthened service with a large m of jewellers has kept him in direct touch with precious stones as ticles of commerce, and gives an eminently practical character and lue to all his information; further he has visited and personally amined many of the localities which it is his province to describe: nce 1882 he has been engaged as the writer of an annual report on the ecious stones of the United States for the Division of Mining Statistics. ence, as might have been anticipated, this volume includes a vast nount of useful information which is otherwise inaccessible both to the ident and general public.

The minerals discussed are not only those which are regarded as pre- ous, but all those which are used for decorative purposes, and include, for ample, sodalite, meerschaum, fluor, and pyrites. There are also apters on pearls, and on aboriginal lapidarian work in North America.

The work is creditable at once to the author and the publisher: it is inted with large type and on thick paper, while the eight coloured ates are themselves sufficient to make the volume a *livre de luxe*. For ese plates no praise can be too high; such representations have never en seen before in any mineralogical treatise: especially worthy of tice are those of cyanite, garnet, tourmaline, microcline, emerald, beryl, ethyst, rutile in quartz, and pearl. There are also sixteen full-page ustrations, and twenty smaller ones in the text. L. F.

8°
6°
4° West of Mexico City 2°
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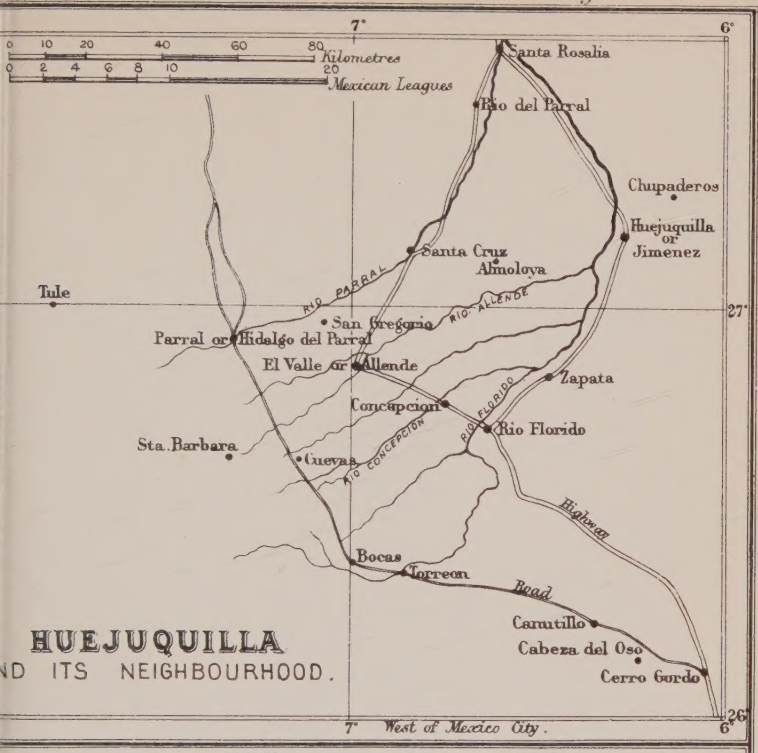
2°
32°
30°
28°
26°
24°
22°
20°
18°
16°
Paso del Norte
UNITED STATES
RIO GRANDE
RIO PECOS
Presidio del Norte
FORT LEATON
Cuchillo Parado
San Carlos
Presidio San Vicente
San José de las Piedras
Eagle Pass
Fort Duncan
Zaragoza
San Antonio
Chihuahua
Santa Eulalia
Spring
Spring
Spring
Narmiento
Sta Rosa de Muzquiz
Santa Rosalia
Rio del Parral
Santa Cruz
Parral or Valle de San Bartolomé
Allende
Rio Florido
Santa Barbara
Bocas
Parreon
Cerro Gordo
Mapimi
San Lorenzo
LAGUNA DE TLAHUALILA
LAGUNA DE MAYRAN
Parras
San Lorenzo
Saltillo
Cerralvo
Monterey
Matamoros
Santiago Papasquiaro
Yerbaniz
Cacaria
Durango
La Punta
Nombre de Dios
Mezquital
or San Francisco del Mezquital
Mazapil
Potosi
Venegas
Poblazon
Catorce
Zacatecas
Mal Paso
Charcas
Bocas
San Blas
Cienegulla
Caquio
Irapuato
Pacula
Tomatlan
Tepetitlan
Ixtlahuaca
Toluca
MEXICO
Tejupilco
Cuernavaca
Amecameca
Cuautla
Iguala
Chilpancingo
Yanhuitlan
Teposcolula
Acapulco
MEXICO.
Mexican Leagues.
English Miles.
Kilometres.



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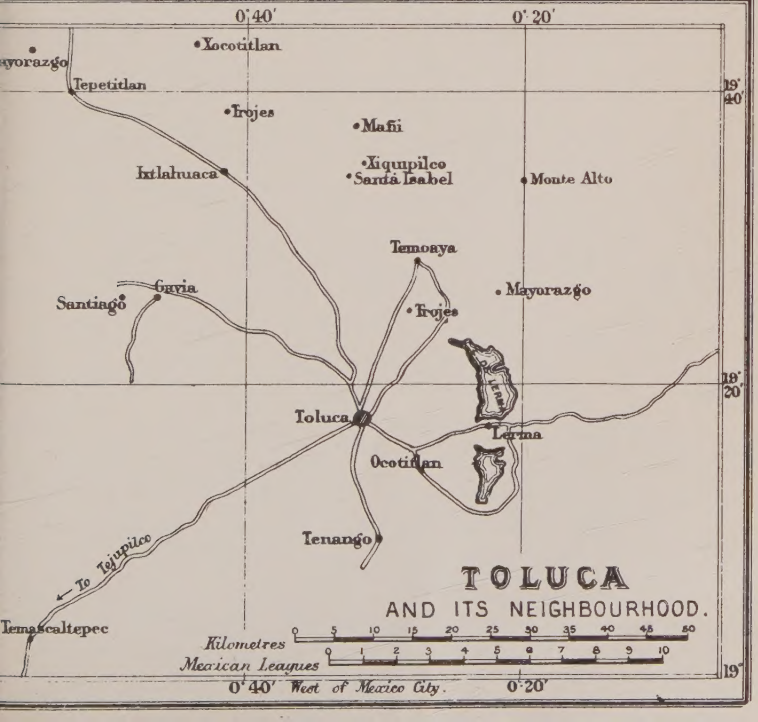

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